THE JOURNAL

OF

Comparative Neurology

A QUARTERLY PERIODICAL

DEVOTED TO THE

Comparative Study of the Nervous System.

EDITED BY

C. L. HERRICK,
Professor of Biology in Denison University.

C. JUDSON HERRICK,
Fellow in Neurology in Denison University.

VOLUME V.

PUBLISHED BY THE EDITORS.

GRANVILLE, OHIO, U. S. A.

R. Friedländer & Son, Berlin, European Agents.

1093

The Journal of Comparative Neurology.

Contents of Vol. V, 1895.

MARCH, 1895.

Pages 1—70, i—xxvi.

JULY, 1895.

Pages 71—138, xxvii—xlii. Plates I—VIII.

DECEMBER, 1895. Double Number.

Pages 149—214, xliii—cii. Plates IX, X, and XI.

764

MODERN ALGEDONIC THEORIES.

By C. L. Herrick.

A great deal of attention is just now turned to various phases of the problem of pleasure-pain. This is no doubt largely due to the interesting results of experimental research upon sensation which has revealed unexpected physiological relations and awakens the hope of getting at a physical basis for the more recondite but closely allied feelings. The most comprehensive recent work on pleasure-pain, which we may take as the text of this paper, is that of Marshall[1] which is perhaps already known to most of our readers.

We may add in passing that in typography and all that pertains to book-making the volume is quite satisfactory and, what is most surprising for a book from the Macmillan press, is tolerably bound. The author's work is thoroughly done and bears evidence of long study and reflection though not of personal investigation. It is a book that has been written rather than forged.

The point of view may be gathered from an introductory paragraph, "Pleasures and pains may be differential qualities of all mental states, of such nature that one of them must and either of them may, under proper conditions, belong to any element of consciousness."

It is interesting to compare the views of a still more recent writer upon the same subject. According to Külpe three views are possible respecting the nature of feelings. 1st. The feeling is a peculiarity of sensation. 2d. Feeling is a function of sensation. 3d. Feeling is an independent process of con-

[1]Marshall, H. R. Pain, Pleasure, and Æsthetics, an essay concerning the psychology of pain and pleasure, with special reference to æsthetics. Macmillan & Co. 1894. $3.00.

sciousness. Against the first view he decides because we find the same peculiarities, quality, intensity, and duration, which are ascribed to sensation. It is illogical then to speak of a process having these properties as a property of sensation along with the self-same properties. When the above properties disappear the sensation of which they are properties disappears with them but the feeling may vanish and the sensation persist. Feeling cannot therefore be a necessary attribute of sensation.

Feelings are in a sense functions of sensation in so far as an observed parallelism exists, but feelings are not directly dependent on the qualities of sensation. Nor is it directly obvious that the intensity of sensation determines its accompanying feelings.

The so-called elementary æsthetic feelings due to form and relations of sensation vary too much to stand in any fundamental relation to sensation. The author chooses the third view, that feelings constitute independent elements of consciousness.

But to return to Marshall; accepting four fundamental mental activities, sensation, emotion, intellect and will, he finds pleasure-pain much more closely connected with the former than the latter pair.

In favor of the view that pleasure and pain are sensations Mr. Nichols has urged that pains are as disparate as are many sensations. Mr. Marshall very properly replies that in those pains which seem most distinct there is always something beside the pain—a cutting, or pricking or the like which forms its criterion and serves to isolate it. We may add that pain and pleasure are *per se* essentially non-localizable. It is association with sensation which adds the localization. Pain from its character is much more likely to be thus associated, as we shall see, and this accounts for the fact noted by Marshall that the common usage is more likely to speak of pain as a sensation and pleasure as an emotion.

A second argument for the sensational nature of pain is derived from the fact that mechanical treatment may induce pain in a nerve trunk while no manipulation of them can pro-

duce pleasure. This is not entirely true for there is a more or less disguised pleasurable sensation due to striking the "funny bone" but, in general, Marshall's reply seems apt. The methods used in stimulating nerve trunks are, in the nature of the case, not normal. No evidence of special pain nerves, he claims, has been adduced. The fact that pain often is perceived after the sensation he explains as due to "the tendency ingrained in us to consider with promptness those elements in our experience which enter into the make-up of objects." We believe, however, that there are very simple physiological explanations of the delay. First, in many cases the delay is due to the fact that the causes of the painful sensation are secondary, such as congestion or vaso-motor changes and that these and not the primary irritation are the real sources of pain. A gross illustration is afforded by the pain felt when a pressure is removed from an inflamed spot, for example. Second, severe pains, in their passage to the brain, do not move along the direct sensory channels but by continual accumulation and overflow break away to the sensory centres via gray columns of the cord. A violent pain cannot be transmitted along the relatively narrow nervous channel of the fibre but by a series of explosive overflows finds its own way to the brain exciting sundry reflexes as it goes. This suggestion harmonizes the facts observed by Schiff, Myers and others which have been supposed to indicate the existence of special pain nerves. It is entirely possible for the fibre tract conveying sensation from a limb to be severed and yet the painful overflow to pursue its independent course to the brain when the anæsthetic region is injured. On the other hand, it is easy to see that hypnotic suggestion might effect a dislocation of the cell paths for pain without destroying sensation in the region considered. A great deal of spurious physiology has associated itself with these pleasure-pain speculations, among which may be noted Courmont's theory in his book "Le Cervelet et ses Fonctions," that the cerebellum is the seat of pleasure and pain. It is unnecessary here to follow the full and to us conclusive refutation which Marshall offers of the theory that pain and pleasure are sensations. The closing object-

ion to the theory, however, is worthy of special notice. Mr. Marshall does not believe that reproduced images of pleasures or pains similar to reproductions of sensation occur. A pleasant sensation may be revived or a painful one but not the pain or pleasure alone.

We remark here that, on the other hand, reproduced sensations are prone to produce present pains or pleasures to a very exalted degree. One sees a train passing and has all the acute emotional disturbance accompanying being thrown under the wheels.

The next step is to show that pleasure-pain cannot be identified with the emotions. "Emotions are the relatively fixed psychoses (instinct-feelings) coincident with correspondingly fixed coördinations of instinctive activities arising upon the presentation of determinate objective conditions."

If the definition helps little we are aided by a list including joy, dread, relief, love, fear, anger, surprise, etc.

Marshall admits that great physiological changes accompany emotions, quoting with approbation James' statement: "The bodily changes follow directly the perception of the existing fact, and our feeling of the same as they occur is the emotion," but seeks to avoid the idea that emotion is caused by the expression. Mr. Marshall cannot reconcile pleasure-pain with this definition of emotion. Emotions require no such perception. He suggests three possibilities :

A. Pleasure-pain may be fundamental—the basis of all psychic life out of which others have risen by development.

B. They may be elements *sui generis*.

C. They may be *quales*, special qualities common to all mental phenomena.

Horwicz supports the first in his *Psychologische Analysen* but does not succeed in tracing the line of evolution convincingly. It is apparent that "Gefühl" must be extended much as Spencer has extended feelings in order to adapt it to such a theory. Compare Ziegler, "Das Gefühl." The second theory is practically an abandonment of the attempt to analyse feelings and has no support from the physiological standpoint. Wundt

brings to bear the theory of apperception but the latter is itself much in need of explanation. Marshall adheres to the third view that pleasure-pain, like intensity, form *quales* of all presentation. According to this view it is not necessary to assume any special organs or nerves for pleasure-pain.

In Chapter IV is a comprehensive discussion of the physical basis of pleasure and pain. Five groups of theories are recognized; first, that pain is an overstepping of the limits of normal activity. Pleasure consists in a return to the normal state. The fatal objection to this theroy in its simple form is the failure to account for pleasures of exercise.

Second, pain is due to tension, pain to equilibrium. This theory also fails to account for pleasure of exercise.

Third, pleasure and pain are contrast phenomena, one being the absence of the other. This theory fails to accord with facts of familiar observation.

Fourth, pain is due to limitation or restriction. Such theories the author thinks fail to account for pleasure. On the contrary, in no direction are physiological suggestions more direct than in emphasing the connection between free irradiation of stimuli and pleasure. The fifth class includes such as connect pain with activities dangerous to the system and pleasures with healthful function. The great number of exceptions to this rule shows that however true this may be as a tendency it cannot constitute the basis of pleasure and pain.

As a working hypothesis Mr. Marshall formulates the following:

Pleasure is experienced whenever the physical activity coincident with the psychic state to which the pleasure is attached inv 'ves the use of surplus stored force. Pain is experienced whenever the physical action which determines the content is so related to the supply of nutriment to its organ, that the energy involved in its reaction to the stimulus is less in amount than the energy which the stimulus habitually calls forth. It is not a little strange that the author here and elsewhere seems to be oblivious of the nutrition theory of Meynert, which in some respects is a counterpart of his own.

We may profitably pause to compare the above statement with Külpe's analysis. This author recognizes the fact that there seems to be a constant relation between circulatory and other somatic changes and the feelings so that the former may be used as a measure of the latter. Dynamometer, sphygmograph, pneumatograph, and plethysmograph, all assist in estimating the feelings. Under pleasurable excitations the voluntary muscular action is enhanced and diminished under pain. The pulse becomes stronger without being more frequent in pleasure. The reverse is true during painful emotion, though after-effects complicate the matter. During pleasurable emotion the volume of respiration increases and the diameter of the superficial capillaries is increased.

Külpe concludes that an increased excitability of the sensory and motor regions of the cerebrum form constant accompaniments of pleasure. Study of the exaltation states of mania and the depression of melancholia leads to the belief that the sole physiological equivalent of pleasure is the dilation of the cortical capillaries, and that of pain is their occlusion.

Three theories of the origin of the feelings are recognized: 1, the *teleological;* 2, the theory of *peripheral origin;* 3, *the theory of central origin.* The first is simply an application of evolution to the problem in hand. It recognizes all normal physiological processes as the product of selection and inheritance. However, such a theory in its general form is far from affording a detailed explanation of the origin of feelings. The second theory applies only to sensory feelings and affords only analogies for the intellectual.

The author's theory above indicated that feelings are due to the state of excitability of the cortex and the latter to the blood supply is more inclusive than the two special theories of Meynert and Wundt. The latter derives feeling from the reaction of apperception upon sensation. Meynert seeks the cause in the nutritive states. In pleasure there is functional hyperæmia and an altered state of the cell protoplasm, while pain produces anæmia and degraded nutrition. In the latter case translation of the stimuli is impeded and we have, as a result, sum-

mation of stimuli and explosive overflow of an injurious character.

Mr. Grant Allen claims that all strong pleasures result from the escape of stored up potential energy which has been hoarded for a considerable time, but at the same time "pleasure is the concomitant of a normal amount of function in sentient tissues." Marshall calls attention to what seems to him a contradiction here. But upon the hypothesis suggested in this paper there is no contradiction. All normal functioning is to a certain extent pleasurable. Pleasure is the result of the conscious participation in an unimpeded nervous function. The pleasure is enhanced in proportion as the amount of function increases and our attention to it increases (not necessarily varying proportionally by any means, however) until the function is checked or impeded. Such impediment may be offered by the limitation of nutritive power in the cell or by other stimuli impinging upon it from without. If when the normal activity of the cell is reached there are afforded sufficient avenues for the overflow of the stimulus to other like cells, an irradiation takes place enhancing the pleasure-giving power without producing abnormal functioning. This may be the physiological equivalent of what Mr. Allen describes as stored up potential energy.

Horwicz considers pleasure as a restoration of equilibrium. This however must be in a somewhat unusual sense. Physiologically pleasurable excitement is of the nature of restoration of equilibrium in so far as an excitement of one organ is transformed into a quickening of the functioning of all accessible organs but it is rather the method of such equilibration than the fact of it which explains the pleasurable nature of the process. Lotze recognizes the dependence of pleasure and pain on the employment of vital energy but added that a psychic perception of the organic advantage or disadvantage was the immediate cause. Bain seems to correlate pleasure-pain with stored energy and excess but not very intelligently.

Zöllner taught that pleasure is the psychical concomitant or aspect of the transformation of potential energy into kinetic, while the opposite process is painful. This is in effect a resist-

ance theory in its broadest expression. Marshall considers that the fact that pain accompanies destruction of tissue is fatal to the second clause of this theory. We should add that the evidence shows that nearly all if not all nervous functioning consists of rapid alternation of the two processes of metastasis and assimilation and that pleasurable excitements are due to such oscillations while pain may result from interference in the free functioning and transference of energy.

One of the most recent theories of pleasure-pain is that proposed by Mr. B. I. Gilman in a series of lectures published in a syllabus in the American Journal of Psychology, VI, 1. This theory of habit assumes that "the source of all pleasure is the performance by the nerves of activities which have once become familiar to them and that pain has its source in a violation of nervous habitude." Thus expressed it is a physiological theory closely associated with the resistance theory advocated by the writer. It is, however, extended as follows: "Any presentation correlated with a bodily process that tends to fix a habit (increases a trace [i. e. a vestige]) is pleasurable; while any presentation correlated with a bodily process that tends to loosen a habit (decreases a trace), is painful." Note in respect to this theory that such nervous processes as would increase a trace must necessarily be of super-medium nature, they must be unusually strong and therefore consume reserve force (as Marshall). On the other hand those which remove vestiges would be such as pass by explosive outbreak across the ordinary channels and at the same time infringe on the reserve cell content. The process devours not only the interest but the capital of the organism and with the latter goes the vestigés it may contain.

It will be seen, however, that this theory fails when applied closely to the simple sensuous pleasures and pains. As Gilman points out, his theory agrees in part with Aristotle's, who remarks that pleasure is the sign of the perfection of an act as the blooming cheek is of health, and with Herbart's, who says "By pleasure, therefore, I signify a passive state wherein the mind passes to a greater perfection."

But Gilman defines these ideals as laid down by passed ex-

perience of the organism; moreover it is only those realizations which impress them more deeply on the habits of the organism that are pleasurable. His statement of theory is open to the criticism that it attempts to place the matter on a physiological basis without really approximating such an explanation. Gilman's theory is confessedly close to Fechner's stability theory. We need not follow this theory into its æsthetic applications in which field the author finds his most frequent confirmations. We cannot doubt that there is a large grain of truth in this theory and that its presentation will contribute much to the solution which shall finally be adopted.

The same may be said of Marshall's book, with its wealth of quotation and suggestion. In this connection we notice an interesting passage on habit which applies to the theory above noted.

"Pain does not necessarily tend to bring about obliteration of its content in future psychoses; but may, in fact, on the whole, conduce to its vigorous reappearance in pleasurable form."

This fact the author explains upon the theory that repeated excitation increase the storage power [i. e.—the nutrition]. It is, however, capable of another explanation. When a violent stimulus has occurred in a cell group and is checked in its tendency to irradiate, summation occurs until the barriers are beaten down. The frequent repetition of this process sets up a tract of communication, irradiation becomes easy and a supernormal stimulus of this cell complex finally produces pleasure. Thus acquired tastes and thus the pleasures of intricate manipulation are explained simply and consistently. In a larger field too it is obvious that this theory explains the function of pain as preliminary to pleasure. Almost every new pleasure must be acquired by the painful process suggested. On the other hand too frequent and indifferent repetition causes the worn channel to pass off the stimulus with such facility that the threshold of pleasurable excitement is not reached. Attention aids in restoring the pleasure (or in relieving satiety) in so far as it inhibits and dams up, as it were, more or less of such wasteful overflow.

The large part of Marshall's book dealing with æsthetics and the art impulse we cannot include in this sketch but simply recognize its suggestiveness and interest to the psychologist and artist alike.

We add the following notes from Ladd's "Psychology, Descriptive and Explanatory," Chapter IX. *Feeling: Its Nature and Classes.* "With all this hopeful endeavor it will never be possible, however, to reduce to a strictly scientific form the life of sentiment and emotion. It is necessary, in the interests of science, to acknowledge this at the outset, and with the utmost candor." "The real and essential Nature of Feeling, as such, cannot be described . . ." "Description is in language, but language itself is the expression of conceptions and thoughts. And the conception of any feeling differs *toto cœlo* from the feeling itself." Feeling is irreducible. The physiological and ideational theories are both rejected. The theory that feeling is pleasure-pain only; that apparant "qualities" are due to associations—this is simplicity "gone entirely mad."

Feeling is the subjective part of sense-experience. Those experiences therefore which are least objectified are richest in feelings. Feelings cannot be identified with the sensations.

Ladd claims to have abandoned "even the appearance of retaining the old and vicious theory of faculties," but read the following (p. 172). "All the neural processes underlying the different psychic facts are of *one* kind. But we have seen that, ultimately considered, in the light of introspective analysis, all the resulting psychic facts have *three* aspects; they are facts of intellection and connation not only, but also facts of feeling." "*Discriminating consciousness analyses in a triune way what psycho-physics regards as conditioned upon the occurence of a physical change essentially the same.*"

"At any particular moment the kind and amount of feeling experienced has for its physiological condition the total complex relation in which all the subordinate neural processes, set up by the stimuli of that moment stand to one another and the set, or direction, of pre-existing related neural processes."

"We classify the feelings by reference to the intellectual

processes which accompany or occasion them. All attempts at a purely biological classification of the phenomena of feeling are, especially, to be rejected."

"The character and rate of the change which takes place in the sensational and ideational elements of consciousness determine certain characteristic 'feelings of relation.'" Here also belongs the discussion of the use of drugs etc., in affecting the emotions via effect on cerebral circulation etc. The primary forms of feeling are, however, unlike, *as feelings*, *qualitatively* and these differences accompany changes in time-rate of their sensational or ideational "occasions."

Chapter X. Feeling as Pleasure-Pain. The belief in the derivation of special sensations from primitive pleasure and pain is rejected. Pleasure and pain are opposite "tones" of feeling —both alike positive. Feeling may be dissociated from pleasure and pain; i. e. "neutral feelings" are probably possible. Goldscheider's "pain spots" are rejected as not proven. The pathological evidence—difference of rate of transmission of pain and touch, etc., are explained on the basis of diffusion of pain conductions.

Pain results from an undue increase of any cerebral process; but "the varying amounts of our pleasure-pains do not stand to the varying amounts of our sensations as the latter stand to the varying amounts of stimuli."

"All human life develops largely by relegating the immediate effects of our activity, as respects the quantities of pleasure or pain evoked, more and more to the background."

"In general, when the intensity of that unorganizable surplus of nervous excitement, that overflowing commotion of the nervous centres which is the physical basis of feeling, surpasses certain variable limits, pain is the result. It is, perhaps, because the ideal feelings are usually supported by less of this 'semi-chaotic suplus,' that they are less intense."

"All elaborate emotions and sentiments generally furnish some reasons why their tone should be one of pleasure, and other reasons why their tone should be one of pain." There are some *natural* or *normal* sensations which are painful.

We have hitherto made no explicit mention of what is now generally known as the Lange-James theory of emotion. In 1884 James and Lange independently published a theory of emotional consciousness so nearly identical that they may be practically treated as the same. Emotional feeling is for them the effect of those muscular and visceral organic changes which have been usually considered to be expressions of the emotion. The primary effect of the excitement is the organic change, the affection of consciousness is secondary. The various objections which have been offered to this theory have been admirably summarized by James in the September number of the Psychological Review for 1894, and the rejoinder makes some points much plainer than the original statement. One thing which has struck all critics is the fact that the external occasions of a given emotion may be so different with so constant a result. If the symptoms make the emotion the variability of symptoms should have a corresponding variability of sensation. This objection counts for little however. A chill is a very easily recognized and constant sensation, but it may be caused by the workings of a malarial phasmodium, a surface exposure, a mental state, a hemorrhage or one of a hundred other agencies. According to the analogy of the objection noted each form of cause should have its own corresponding species of chill. In our illustration as in emotion the vera causa is a nervous change in the central organ which may be produced in a great variety of agencies. In reading the objections and the rejoinder one is struck with the crudity of physiological concepts employed. Of course much must be conceded to the illustrative use of language, but the force of the whole discussion is chiefly spent on points which would disappear with a clearer apprehension of neural processes. Long before we are justified in looking for the constants of emotional determination we have passed from vaso-motor nerves to tracts or concatenated cell-series in the central system and from these to receptive dendritic plexi and their cellular sources.

The result of the recent discussion has been to bring all students nearer together and to cause all to admit the great importance of visceral changes in determining emotion.

Professor James has made the quite unnecessary admission that if a patient could be found who was quite anæsthetic within and without and yet suffered emotional disturbance his theory would be demolished. A very remarkable case has been reported by Sollier, in which the conditions were very nearly realized and Sollier concludes from this and experimental work on hypnotics that when totally anæsthetic the patient feels no normal emotion whatever at the suggestion of hallucinations and delusions which have the power of moving her strongly when the sensibility is restored. When the anæsthesia is solely peripheral, the emotion takes place with almost normal strength; when it is solely visceral, the emotion is abolished almost as much as when it is total, so that the emotion depends almost exclusively upon visceral sensations. This reporter seems too much like an *ex parte* advocate to be entirely convincing, and other cases have been reported which seem to negative the evidence. However, it must be remembered that one positive affirmative case is worth any number of negative instances for the essential conditions to be supplied lie deeper than the surface indications. All depends on where the circuit is cut. It is quite possible for all *sensation* to be prevented by the degeneration of tracts while concatenated cellular paths by which pain or pleasure stimuli pass remain intact.

In a series of articles published in the Psychological Review, Professor Dewey enters upon the question. Accepting the James-Lange, or as he calls it, the "discharge" theory, he attempts to show that the movements producing emotion all have a teleological value. This is neither new nor remarkable, for it would seem self-evident that from the standpoint of natural selection (a point of view too often neglected in psychological speculation even by those who occupy it in biology) no class of neuroses could acquire an important hold on consciousness without having recognized importance. In the second article Professor Dewey views the Lange-James theory from the teleological standpoint.

"Emotion in its entirety is a mode of behavior which is purposive, or has an intellectual content, and which also reflects

itself into feeling or affects, as the subjective valuation of that which is objectively expressed by the idea or purpose."

Dewey's article is valuable in making clear a difference of usage which has given rise to constant misapprehension. Some, like James, appear to mean by emotion only the "feel," let us say of being angry, while others mean the whole affect or state of anger of which the "feel" is, according to Dewey, a *quale.*

To us it is self-obvious that as psychologists we have only to deal with the conscious elements and however true it may be that the "feel" has no existence by itself as a full-fledged emotion-experience it is yet our obligation to treat it as distinct because we do instinctively abstract it from the impulses following, as from the physiological causes or concomitants though the latter may reflect themselves upon the feeling element never so potently or complexly.

A little careful analysis of James' theory shows that it amounts to this: our feeling of emotion is the psychical apprehension of states of our own body. Well, so are all psychical processes! What are the differentia which separate feelings from other such states? James says the reflected results of reflexes somatic or muscular. But we ask again what are the peculiarities of *these* rather than other stimuli that adapt them to produce emotions? Surely there is nothing self-evident in the suggestion that such reflexes are specially adapted to be causes of emotion. We reply that these and any other stimuli *primary* or *secondary* which tend to overflow the ordinary afferent channels and pass through concatenated cellular series acquire thereby a special character or summation power which is precisely the physiological *quale* sought. As thus stated we escape from many of the difficulties involved in an attempt to limit feeling to a product of motor or somatic responses to a stimulus. The shock which modifies the efferent apparatus is at the same time affecting the afferent.

We are then ready to follow Professor Dewey for whom the connotation of emotion is primarily ethical and only secondarily psychical though we may think he is greatly enlarging its rational extension in making it include a disposition and a way

of behaving—a certain practical attitude. By thus making emotion include sentiment and temperamental moduli he lays his own theories open to easy attack. The mode of behavior is for him the primary thing. The feeling element is super-induced. Thus the instinct to fight may have arisen and become perpetuated by natural selection until it is the inevitable response of the organism to a given presentation but no feeling of anger is necessarily implied. When the impulse is inhibited and is dammed up, as it were, by conscious coördination it becomes anger. Emotion is then the adjustment or tension of habit and ideal. So far as Professor Dewey's theory emphasises the inhibitory element in complex emotions he adds force to our own physiological theory by indicating how the higher emotional elements are translated into the proper physiological terms to produce feeling; namely, by inhibition, which soon gives rise to summation phenomena such as afford the peculiar *nisus* of feeling. We have here a dash of the resistance theory also.

Professor Dewey offers the following summary: "Certain movements, formerly useful in themselves, become reduced to tendencies to action, to attitudes. As such they serve, when instinctively aroused into action, as means for realizing ends. But so far as there is difficulty in adjusting the organic activity represented by the attitude with that which stands for the idea or end, there is *affect*, or emotional seizure. Let the coördination be effected in one act, instead of in a successive series of mutually exclusive stimuli and we have interest. Let such coördinations become thoroughly habitual and hereditary, and we have *Gefühlston.*" We may remark that the theory as thus stated does not explain the appetencies and simple sensuous pleasures or gratifications; it is less happy in dealing with pleasure than with pain; the use of the term "attitude" is very unfortunate; and, finally, it fails to recognize many simple physiological facts. When we have agreed upon the nature of the simplest sense, pain and gratification, the foundation will have been laid for the more complex æsthetic phenomena. This foundation we believe consists in the recognition of a special

kind of neurosis for the feelings due to two classes of stimuli of a very similar but not identical kind. Given an excessive stimulus which for whatever reason freely irradiates and pleasure is felt, given another stimulus or the same excessive stimulus with other neural conditions which prevent irradiation and produce summation and overflow and pain is felt. With this as a basis we are prepared to analyse the emotional complexes as introspection and experiment may permit and refer each member to its own category. It will then appear that most of the conflicting theories have their truth elements and their reconciliation has been hindered by the attempt to seek for solidarity too far from the center.

The tendency is strong now-a-days to seek for a special differentiation of the nervous system corresponding to each psychosis. This leads to repeated efforts to identify a pain organ. One of the most extensive of recent attempts in this direction is that of Frey.[1]

The author pleads for the recognition of a special "pain-sense" as an element of consciousness coordinate with the other senses and also for the existence of distinct end-organs and paths of conduction. The "Gefühlston" does not, then, constitute a necessary attribute of all sensations, but there may be on the one hand, pure (i. e. *unbetonte*) sensations and on the other hand —and much more important—pure feelings independent of ulterior sense-impressions. "Pain spots" can be localized and differentiated from other spots.

Again, some parts of the body are sensitive to pain, but not to touch, i. e. the least touch is painful—e. g. the cornea.

The organs of the pain-sense are spread over the whole body.

The painful sensation is referred much less to the affecting circumstance than to the affected organ.

Pain is peculiar in its intimate association with the reflexes.

May the feelings of desire be placed in some category as pain? The undemonstrable assumption that there is a special

---

[1]FREY, MAX V. Die Gefühle und ihr Verhältniss zu den Empfindungen. *Antrittsvorlesung, Leipzig,* 1894.

sensory apparatus for desire (*Lust*) seems to the author unneccessary for he explains that it is the cessation of pain which produces desire. Desire is in general the more intense the more aversion (*Unlust*) is decreased; in this connection, too, it must be taken into account how rapidly the aversion diminishes (and this, at least partly, by contrast effect).

As at least suggestive along this line we notice that Cavazzani[1] records an interesting and valuable observation, illustrating the fact that different fibres exist in peripheral nerves for the conduction of different sensations, a fact often shown experimentally and symptomatically in certain diseases, but only rarely with such positiveness as in Cavazzani's case. The ulnar and median nerves were divided at the elbow by an injury. Nine months afterwards the ends were re-united. Eight weeks later normal sensation had returned down to the wrist. In the hand, temperature and muscular (pressure) sense were each markedly impaired, and in certain fingers, in very different degree, according as the fingers were supplied by the median or the ulnar nerve, leading the author to conclude that the ulnar nerve carried a less number of fibres for temperature sense, the median a larger number for pressure sense. There was also evidence of the disassociation of temperature sense, since in certain parts of the hand, particularly the end of the middle finger, only cold was felt, while sensation for heat and touch was totally lost.

In connection with Cavazzani's observations, appropriate mention may be made of a paper by Weir Mitchell,[2] describing a rare phenomenon in a clinical example of crossed thermo-anæsthesia,—left side of face and right side of body. Tact and pain sense were both normal, as were also taste, smell and hearing. The symptoms developed as a result of apoplectic seizure. Mitchell was unable to find any record of a similar case. Bremer[3] writes in support of the theory of a central or cerebral pruritus, dependent upon morbid nutritional changes in the cor-

[1]Schmidt's Jahrbücher, Leipzig, June 15, 1893. This and the two following abstracts are taken from the Annual of the Universal Medical Sciences, 1894.

[2]Medical Chronicle, March, 1893.

[3]Review of Insanity and Nervous Disease, Dec., 1892.

tex. He does not believe that the sensation of itching originates in the tactile corpuscles, although readily admitting that these bodies are the media of peripheral expression for the sensation. Certain analogies between itching and pain, touch and temperature sense, indicate a cerebral origin for all forms of peripheral sensorial impressions. He finds support for the theory in the pain of the hypochondriac and the hysterical, the itching of hypnotic suggestion, of neurasthenia and the itching aura in certain cases of epilepsy, etc.

But we have already seen that the evidence is far from convincing for the existence of special nerves for pain and must return to Goldscheider's paper in 1891[1] where, in discussing the summation phenomena of pain, he suggests that the secondary sensation is a summation phenomenon which probably takes place in the cellular elements scattered through the nerve tract. The cells store the energy which goes to them while that which passes directly along the fibres reaches the brain first. Subsequent accessions break down the cellular resistance and thus an explosive incremental stimulus reaches consciousness as pain. A single sensation if excessive may produce the like effect. Now accepting the accumulating evidence of a special cellular course for excessive stimuli we may inquire how simple pleasurable sensations are produced. .Several hints are at our disposal. Many of these pleasures are accompanied by a peculiar nervous diffusion, as in tickling and the genial effect of warmth. This effect is known as irradiation and is also characteristic of higher states of pleasurable feeling. Both pain and pleasure depend on exalted stimuli, but the reaction of the system toward the stmuli largely determines their pleasurableness or painfulness. The same excitation may excite one or the other feeling at different times. Attention has thus a powerful but not regulatable influence. In the higher spheres of pleasure-pain this influence is more marked. This irradiation has a great tendency to involve vaso-motor channels, as we have seen above, while the summation processes of pain awaken various reflexes in their path

[1] Dubois Reymond's Archiv, 164.

which may increase the effect on the centres in a secondary way. Thus a somatic change, as sickness at the stomach, may be almost or quite coincident with the pain. To the above we may add the essential elements of Meynert's nutritive theory. It is obvious that the responsiveness of a cell is directly affected by its nutritive state and familiar experience shows that a state of malnutrition, whether of the body at large or the nervous system in particular, predisposes to pain and thwarts pleasure. The stimuli which ordinarily are indifferent or even pleasurable becomes sources of torture.

In extending the application of these suggestions to the emotions we may notice Professor Ladd's treatment in his most recent work of the somatic basis of emotions.

"Since all forms of feeling, when intensified so as themselves to feel, as it were, in a secondary way, the bodily resonance they occasion, become emotional, the development of each kind of emotion, as well as the development of the entire life of emotions, requires us to consider the somatic influences that are distinctive of them all."

"An emotion, physiologically described, may be considered as a sort of nerve-storm which gathers intensity, at first, in some comparatively limited region of the brain, but quickly spreads from storm-center to storm-center, as it were; which sweeps down the different paths of exit upon the lower centres and upon the different systems of muscles, upon the vascular and secretive and respiratory systems; and then from all these peripheral parts, return currents sweep backward further to disturb the centers that lie within the brain." [1]

Compare also the following passage from another recent author: [2]

"Pain and pleasure do not originate where thought is developed, but are alterations of the functions of organic life rendered apparent through the agency of the medulla oblongata. This, then, is the centre of pain and pleasure, whether pro-

---

[1] Ladd—Psychology, Descriptive and Explanatory, p. 544.

[2] SERGI, G. Dolore e Piacere, Storia Naturale dei Sentimenti. *Milan*, 1894.

voked by organic, physical, sensible stimulus in any part of the body, or by perceptions, ideas, thoughts transmitted through the brain. It is from here that the impulses proceed that modify and disturb the organic life, beginning with the heart and the respiration."

Finally, then, we venture to quote nearly in full from the Supplement to Woods Reference Handbook of the Medical Sciences an article embodying our own ideas respecting emotions, in their physiological relations :

The scholastic and convenient tradition which divides psychical manifestations into cognitions, volitions, and feeling, permits us to single out a class of so-called mental manifestations, which are conceived to be determined by a form of the receptivities of mind known as the susceptibilities. The most careful writers have discovered in this group of "faculties" a perennial source of dispute and ambiguity.

Older psychologists conceived of feeling as obscure or implicate thought, or as impotent or unexpressed impulse or will.

Hoeffding defines feeling as "that in our inward states which cannot by any possibility become an element of a percept or an image;" as "an inner illumination which falls on the stream of sensations and ideas." Both these expressions indicate the difficulty involved in isolating feelings, the one being negative, the other an illustration. Sibbern notices that feelings and will have this in common, that in both "the ideas involved have a personal hold and effect, so that we yield ourselves up to them and are incited to act and strive for their realization." Recognizing the futility of the distinctions usually made, James has boldly used feeling as synonymous with the word psychosis or subjective state, and made no attempt to distinguish it from thought. The emotions (German *Effecte*) are described as a bubbling up of feeling which may greatly influence the course of cognitions and volitions, or temporarily inhibit or stimulate them. If emotions be strictly limited to feelings with psychical (cognitive) occasion or accompaniment, much ambiguity may be avoided, but it would still be necessary to insist on the es-

sential similarity of these feelings to others with simple sensational basis. The following classification may prove convenient:

I. *Feelings.*	Sensations.	Sense gratification and pain.	General or total feelings.
II. *Occasions.*	Normal (moderate) sensory stimuli.	Super-normal stimuli, with tendency to irradiate.	Diffuse (somatic, especially "total") stimuli.

Emotions.	Impulses.	Sentiment.	Disposition.
Somatic changes occasioned or accompanied by cortical activity.	Reflexes excited by somatic and cortical activity.	Persistent cortical changes.	Reactions of cortical residua on new data of consciousness.

This series of subjective states is not to be regarded as arbitrary, but capable of the most far-reaching inter-penetrations. Of course it may be claimed that there is a great gap between sensation, or even bodily pain and pleasure, and the emotions which depend chiefly upon data of a higher intellectual character. Between these two groups is another, which seems, in part at least, to bridge over the interval, the total or general feelings.

Sensations, as the most direct responses of the consciousness to external irritations in which the bodily participation is more direct than in the subsequent processes (perception, etc.), afford the simplest data of consciousness. Even in this case, however, the nature of the response varies with the organ in respect to the amount of subjective participation. Thus, sensations are excentrically projected or externalized; the former in the case of tactile, gustatory, thermic, and algesic senses; the latter in the case of special senses—visual, auditory, and olfactory.

That this is not a primitive difference, but is developed through associations of several senses, is proven by such facts as that when a blind person is suddenly given sight, the external world seems to touch the eye, *i.e.*, is excentrically projected rather than externalized. That externalization is possible to the tactile sense or "muscular sense" is shown by hyperexcen-

tric reference of sensations of double contact, as when the blind man seems to feel an object at the end of his cane, or the surgeon's sensation is transferred to the end of his probe. We may dismiss, as beyond our limits, the three sciences—optics, acoustics, haptics (the skin and muscular sensations)—and there still remains a set of sensations which may be conveniently grouped as general sensations, which bring us into closest relations with the lower special senses, olfaction and taste, and the diffuse sensations on one hand, and subemotional processes, like elation, ennui, and depression, where total sensations and rudimentary feelings fuse.

It must not be forgotten that pain and sense gratification are strong elements in the emotions and require a careful examination. Hoeffding says "feeling stands out plainly, as an element different from the actual sensation, in certain experiences, which prove that the pain caused by an excitation takes longer to be produced than the actual sensation, and that sensation may arise without the corresponding feeling, and *vice versa.*" Richet says "pain without memory and without radiation would be no pain at all." Often an interval of one or two seconds may elapse after the sensation is perceived before pain appears. These cases, so often quoted as proving the distinct nature of pain, are in one respect fallacious. When a nerve-fibre is penetrated by a pin the pain is nearly, if not quite, as promptly felt as the touch. When the finger is struck by a hammer the pain is frequently long delayed. But the acme of pain in that case is due to a reactionary process in the tissues, notably the vascular contractions, etc. There may be several oscillations of pain and a set of summations of a curious character. It is even possible, by bringing to bear counter-irritants, to preclude these after-effects and mitigate the pain, as by rubbing or pinching the part.

In the case of a burn the conductivity of the tissues and vascular responses are even more evident, and such attempts to differentiate pain from sensation as a modality of feeling are futile. The fact that there may be analgesia without anæsthesia, and *vice versa*, is tentatively explained by the recent suggestion,

that thermic and painful sensations find their way to the cortex through the gray matter of the cord instead of the fibrous columns, and affords us added data for the generalization for which we are now ready, viz : Feeling is always composed of two sets of factors ; first, a sensational, and second a cognitive or intuitional element. The sensations which directly participate in feeling are non-localized (general or total sensations), or are so acute as to irradiate, and thus ally themselves with total sensations. The cognitions or intuitions are primarily such as identify the subjective state with the empirical ego. The association of reflexes and instinctive responses converts the feeling into an impulse which is usually embodied in the so-called emotion.

James identifies instincts and emotions as two forms of impulse, in this usage betraying German influence. He says that the class of emotional is rather larger than that of instinctive impulses. Its stimuli are are more numerous, and its expressions are more internal and delicate, and often less practical. The physiological plan and essence of two classes of impulse is the same. This identification of the expression of the emotion with the psychical element (feeling) seems illogical, inexpedient. Instincts may have an emotional origin, or may be of the nature of impulse deprived of its psychical element ; but pure instinct is not emotional, though emotions may be awakened by a resistance to the gratification of the instinct. An impulse stands on a present or historical basis.

With this difference in distribution, the theory of emotions proposed by Professors Lange and James goes far to place the emotions on a plane of scientific research. As expressed by the last named, his theory is about as follows : Bodily changes follow directly the perception of the exciting fact, and our feeling of the same changes as they occur is the emotion. Objects excite bodily changes by a pre-organized mechanism, and these changes are so indefinitely numerous and so subtle that the entire organism may be called a sounding-board, which every change of consciousness, however slight, may make reverberate.

Everyone of the bodily changes is felt acutely or obscurely the moment it occurs.

James says: "If we fancy some strong emotion, and then try to abstract from our consciousness of it the feelings of bodily symptoms, we find we have nothing left," . . . "a cold and neural state of intellectual perception is all that remains." "The more closely I scrutinize my states, the more persuaded I become that whatever moods, affections, and passions I have are in very truth constituted by, and made up of, those bodily changes which we ordinarily call their expression or consequence." These quotations serve at least to emphasize the importance of the corporeal element, however much they ignore the cognitive element. The natural and logical criticism is that the *effect on consciousness*, which is all we get out of feeling, is wellnigh overlooked.

Emotion consists (1) of general sensations of total, organic, or irradiating varieties which have in common a lack of localization and, as a result of associational laws, are amalgamated more or less closely with the empirical ego; (2) of more or less explicate or implicate cognitions (perceptions, intuitions) of the relation between the cause of the sensation and our well-being; (3) the emotion is more or less closely attached to various impulsive expressions which tend in various ways to intensify the two preceding. More in detail: The sensations are produced in most cases by vaso-motor changes which, in turn, produce "total sensations," usually entirely unlocalized and not necessarily distinguished apart from the feeling. Such sensations may be recognized, and to some extent analyzed, by practice. They precede the emotion proper and compose its sensational element. When one lies half asleep in the morning and a loud report startles him, the sudden surging of the blood to the periphery produces a familiar but indescrible sensation, which may include tingling at the finger-tips, a curious twinge in the axials, a suffocating sensation in the chest, as more specific accompaniments. Then a flash of fancy depicts the burglar in the kitchen and a scene of bloodshed, danger to self, and the like; now perhaps a strange "gone" feeling in the abdomen, and a helpless atonic condition

of muscles follow; then impulse dominates, and the tendency to spring to the defensive arises; all this before judgment announced that the cook has slammed the range door. Granting that the illustration has served to indicate the meaning of the statement above, it need require but brief experiment and self-observation to show that vaso-motor and organic changes always accompany and afford a sensational basis for feelings. A just analysis will not neglect the subjective process in construing the physical. Stripped of the sensations above referred to, and the instincts and impulses associated with them, the residuum is still not to be passed over. "A feelingless cognition that certain circumstances are deplorable," or otherwise, may be, and generally is, but the first step in a series of judgments or representations out of which spring the involuntary acts which are the really important results of emotion. The sensational element is that which represents the general, though subtle, bodily effect of the stimulus (be it physical or psychical), while it serves to awaken within us the empirical ego (the sum of our purely subjective bodily reactions on consciousness), which gives point or poignancy to the following psychical processes and links self with phenomena, awakening the participation of the soul in the states of the body, or of other beings, which otherwise might concern us only as do phenomena in Mars. It is then no mere figure which localizes the emotions in the heart or bowels, but a statement of sober physiological truth. A heartless man is one whose intellectual appreciation of the results of an act does not awaken sympathetic thrills in his physical being adequate to quicken in him a participatory or sympathetic state. Such a condition may be acquired by habit or produced by heredity. Practically, we are first interested to study the physical substrata conditioning the emotional temperament and its expressions.

The sensrtional elements in emotion are, first pains and sense gratifications; second, obscure organic and total sensations which are not usually perceived as such, but are interpreted as part of the feeling; third, reproduced pains or gratifications always followed or accompanied by total sensations;

fourth, representations which awaken by association either reproduced pains and gratifications which, in turn, give rise to total sensations, or the latter without the former ; fifth, instincts, which obey laws of association whose rational explanation lies in the development or phylogenetic history.

Pain and sense gratification are more difficult to construe, because more direct and simple than the others named. So long as pain, etc., were regarded as simply exaggerated forms of ordinary sensation the problem was insoluble. That this is not the case is suggested by the fact that they pursue other courses in the cord, and are associated more closely with thermic sensations. If a small area of the skin is isolated it is found that tickling with a feather is interpreted as warmth, and a thrust with a needle cannot be distinguished from heat. In other words, if the local signs by which position is recognized are excluded, the differences break down. It may be noted that general changes in temperature states are closely connected with the general feelings, as witness a shudder or the cold chills of fear, and the glow of pleasure. Briefly stated, the peculiarity of pain and intense gratification of sense which adapt them to become sources of feeling, is their diffusive (irradiative) character. If the current suggestion that algesic stimuli pass by conduction through the gray matter of the cord be substantiated, a much closer connection with the visceral centres than hitherto suggested may be postulated, and the thrill of pain can be readily interpreted as the sympathetic contraction wave passing throughout the vascular system. The evidenee for the existence of adequate vaso-motor causes of the sensational element in emotion is largely subjective, but those familiar with nervous diseases will not lack for evidence that variations in circulation are powerful factors in emotional disturbance. Shame is an emotion quite independent at times from any judgment of adequate occasion for chagrin. It is very closely connected with peripheral vascular changes. In anæmic or neurotic persons the flush may come without any external exciting cause, and yet frequently produces all the subjective effects of shame. Not very infrequently this symptom becomes intolerable and almost

alone drives one from society. Still more frequently psychical reflexes become associated with it and enhance its power. Fear, which originates in a shock or contraction wave of the vascular system, bringing a whole series of visceral and secretory changes in its wake, illustrates the possibility of separating the sensational from the cognitive element. Dreams often afford instances of all the physical manifestations of fear, with no adequate cognitive process. The writer has dreamed of being the actor in a play in which fear of impending danger entered, and, in his capacity as actor, felt fear (sensational); while in his capacity of critic he, at the same time, observed the entire inadequacy of the supposed occasions of fear.

Lange says: "No one has ever thought of separating the emotion produced by an unusually loud sound from the true inward affections. No one hesitates to call it a true inward affection. No one hesitates to call it a sort of fright, and it shows the ordinary signs of fright. And yet it is by no means combined with the idea of danger, or in any way occasioned by associations, memories, or other mental processes. The phenomena of fright follow the noise immediately, without a trace of spiritual fear. Many men can never grow used to standing near a cannon when it is fired off, although they perfectly know that there is danger neither for themselves nor for others—the bare sound is too much for them." One who has walked over a railroad trestle by night and narrowly escaped a fatal plunge by observing just in time the absence of a tie, will be able to recall the peculiar series of organic sensations involved. The thrill of vaso-motor disturbance pervading the body—the twitch of the radial artery—the pain in the sternal region—the suffocating sensation in the breast and lump in the throat—and finally, the "gone" sensation in the abdomen somewhat resembling a sensation of cold, and due in all probability to vaso-constrictor reactions in the visceral vessels—these, and many more, illustrate the bodily effects which may wholly precede the apprehension of danger, and may be enhanced by a variety of imagination pictures, and may express themselves in impulsive gasps and gestures. It is not necessary to call attention to the fact that

mental images may be almost equally effective with the actual external irritations in producing the sensational responses of emotions. Before passing from the direct sensational elements, however, it may be noticed that those senses which externalize their data (vision, hearing, etc.) have special powers over the emotions which may in part be explained by a sort of central (bulbar?) irradiation. Simple colors aad musical sounds produce a vague and feeble pleasure unworthy to be called emotional, but similar to the normal subjectivity of nervous action; but a symphony or aurora plays on the sensitive organism like a harp. The writer, without musical tastes or education, confesses to the tumult of indescribable sensations produced by Wagner or Beethoven. Flushes of cold and heat; tinglings and palpitations local and general; gusts and torrents in the blood; creeping, swelling, scintillation of the skin; giddiness and elation—these and indescribable "all-over" sensations are easily separable from intellectual appreciation, which may even be absent; and one may be a wandering spectator observing the irrational gyrations of his own sense to tintinnabulating stimuli upon which judgment turns the cold shoulder. Another class afforded by the tickling and shuddering, or irradiation sensations proper, further illustrates the necessity of diffusion in emotional sensation. The slight sensations of tickling, aided by subjective modifications, extend in most varied and irresistible sensations over the whole body. Its emotional character is almost wholly apart from the intellectual element. The shudder and chill which spring from a gritting sound or the velvety touch of a peach, imply in addition considerable instinctive elements.

The effect of instinct is powerful in the emotions generally. The faintness at sight of blood may be entirely apart from apprehension, The universal creepiness inspired by the approach of a harmless snake or the proximity to a precipice, are illustrations of a form of sensation obviously highly developed in animals (witness the rising hair of the new-born kitten at the odor of a dog). The sight of many small animals, pets, or children, produces a marked thrill in most children, often accompanied by curious sensations at the root of the teeth (analogous to the

sensation sometimes felt with surcharged bladder), and accompanied by strong impulse to squeeze or hug the animal, to contract the muscles of the jaws, arms, etc.

These are often very powerful sensations, and productive of almost violent impulses. They are analagous to certain sexual instincts (perverted in gynophagia, etc.), but are quite distinct from them.

The impulses of emotion have received careful study, and only too often have been identified as part of the feeling. If it were desired to analyze emotion as of three-fold character, thus: sensation, cognition, impulse, there could be no serious objection, except that impulse doos not always require consciousness of its occasion as emotion must. Strong evidence as to the nature of emotion is afforded by the fact that imitation of the expressions of emotion reflexly awaken the emotion, while vigorous repression of these impulses quickly obliterate it. Distraction of the attention may check the tempest rising in a child's bosom which, once overflowing, could only find relief in exhaustion.

Many persons who are not suspected of neurotic disease, have a transitory mania which exhibits itself in paroxysms of fury as blind and unreasonable as those of a maniac, and which may be occasioned by trivial circumstances. The fact that impulsive responses to emotional excitation have this reflex power is a significant one in the treatment of nervous disease. Bucke's description of nervous dyspepsia may find a place here. "All physicians who have been much engaged in general practice have seen cases of dyspepsia in which constant low spirits and occasional attacks of terror rendered the patient's condition pitiable in the extreme. I have observed these cases often and have watched them closely, and I have never seen greater suffering of any kind than I have witnessed during these attacks. . . . Thus a man is suffering from what we call nervous dyspepsia. Some day, we will suppose in the middle of the afternoon, without any warning or visible cause, one of these attacks of terror comes on. The first thing the man feels is great, but vague discomfort. Then he notices that his heart is beat-

ing much too violently. At the same time shocks or flashes, as of electrical discharges, so violent as to be almost painful, pass one after another through his body and limbs. Then in a few minutes he falls into a condition of the most intense fear. He is not afraid of anything; he is simply afraid. His mind is perfectly clear. He looks for a cause of his wretched condition, but sees none. Presently his terror is such that he trembles violently and utters low moans, and at this stage there are no tears in his eyes, though his suffering is intense. When the climax of the attack is reached and passed, there is copious flow of tears, or else a mental condition in which the person weeps upon the least provocation. At this stage a large quantity of pale urine is passed. Then the heart's action again becomes normal and the attack passes off." It is not the purpose of this article to suggest remedial or obviating proceedure, but it is obvious that the vaso-motor conditions in hypochondria and nervous acme of all kinds acquire new significance in this connection.

Another group of phenomena connected with emotional excitement has recently been adverted to.

In a paper before the International Congress of Experimental Physiology, session of 1892, Professor Hugo Münsterberg details the results of experiments, showing that the emotional states react differently on the entensor and flexor systems of skeletal muscles. After having for some time practised moving an index on a scale ten or twenty centimetres centripetally and centrifugally, until the distance could be quite accurately estimated with closed eyes, he tried the same experiment while experiencing pleasurable and painful emotions. The results are interesting. Purely physical variations, such as would be expected *a priori*, are seen in the under-estimation of the distance in dull or serious moods, and over-estimation when excited or amused. But psycical variations appear when they would hardly have been expected. Thus in unpleasurable emotions the extensor motions are too small, while flexor motions are too large, and during pleasurable emotions the flexor motions are too small and the extensor motions too large. The

author does not hesitate to found on this observation the theory, that it is not simply true that painful emotions produce flexor motions and pleasurable emotions extensor motions, but that the psycho-physical effect of the reflexly produced extension and flexion is precisely what we term pleasure or painful emotion. A farther generalization is that extension must always, from the biological stand-point, occur with serviceable, and flexion with harmful, irritations.

Even the infusoria exhibit the same tendency. This lies at one extreme, while at the other the pleasurable emotion of assent is but an associated reproduction of earlier extensor motions, and *vice versa.* Pain and pleasurable sensations acquire emotional value only through the aid of associated muscle sensations, *i.e.*, such as form the foundation of our empirical ego.

These suggestions are expressed in a somewhat different form in Tuke's well-known text-book. "By acting chiefly on the flexor muscles, fear causes the general bending or curving of the frame; while courage contracts the extensors, and produces expansion and height."

"The opposite muscular states of contraction or tension and relaxation alike find illustration in the emotion of terror, for with the signs of the former already mentioned, and the stare of the eye, are combined the relaxation of the masseters, the sphincters, and the processes of organic life." "Calmness —a placid condition of the feelings generally—is marked by a gentle contraction of the muscles, indicative of repose, but at the same time of latent power—by the countenance free from furrows, but not relaxed into weakness. Anger or rage contracts the masseters, inflates the nostrils, furrows the forehead, and exposes and rolls the eyeballs, clenches the fist, and induces a violent action and more or less rigidity of the muscles generally."

"As all movements have for their great end the preservation as well as the enjoyment of the individual, and as contraction and relaxation take place primarily to attain this end, a general expansiveness of expression and gesture is allied with all the emotions which are excited by impressions (or generated

by ideas) of a beneficent character; while a general exclusiveness or contraction of features is allied with emotions excited by maleficent expressions; the object of one class of movements being to court and receive, and of the other to avoid and reject." "Pleasurable and painful sensations from without determine, then, the form which the muscles called into action assume; the purpose being to protect the organs. Similar muscular changes arise from the emotions, according as they are pleasurable or painful, in consequence of the harmony between mental and bodily acts."

The existence of impulses of the most recondite and adaptive sorts need not be denied, nor can it be doubted that these reflexly contribute to the emotional element. It must be urged, however, that emotion, strictly speaking, is subjective and must not be identified with its bodily occasions or results. The practical problem is to acquire control over the conditions.

The transition from emotion to sentiment is imperceptible. Joy and sorrow are sentiments growing out of pleasure and displeasure, and these have their counterparts in sense gratification. Conjugal love is the sentiment of which passion is the emotion, for which erotic excitement may afford one sensational basis.

The rhythmical flux of the feelings is explained by physiological oscillations. In the morning, when the current of life is full, emotions are not easily awakened. A morning audience is not a responsive or emotional one. The processes of nutrition exert a powerful effect. Physiological acme, like puberty, and the climacteric, predispose to emotions. The early development of the sensational element of emotion and its preponderance in the lower animals has been thought to imply that feelings are prior to cognitions. A more just analysis recognizes the psychical element of emotion as essentially intellectual, and abandons the attempt to secure a serial relation of the "faculties."

URANISM, CONGENITAL SEXUAL INVERSION.

Observations and Recommendations by

MARC ANDRE RAFFALOVICH.

INTRODUCTION.

> Filiæ Luxuriæ sunt octo, scilicet cœcitas mentis, inconsideratio, præcipitatio, inconstantia, amor sui, odium Dei, affectus præsentis sæculi, et desperatio futuri sæculi.
>
> —THOMAS AQUINAS.

I have neither desire nor time to write an encyclopedia of inversion, still less to review the discoveries, the opinions and the assertions of other writers and their followers or adversaries. I have wished primarily to submit to my readers certain observations as new and as exact as possible. I have criticized with all possible respect my predecessors, masters or followers ; and I have decided to make an appeal to all those who have at heart the dimunition of suffering and debauchery among the children of the present or the coming generations.

The education of congenital inverts (or uranists, to employ the word invented by a famous invert) has not yet been undertaken. We are strangely ignorant of the indices of homosexuality in children. Homosexuality is increasing and will increase. We can hardly cure the inverts. Hypnotism is not satisfactory and marriage is the worst of remedies, sacrificing the peace and health of the children to the improbable cure of the father and his doubtful restoration. There are already too many inverts and perverts who are married and who are fathers and hypocrites for marriage to save the honor of a homosexual.

The education of the uranist is a desideratum ; it will be ere long a necessity. If we apply ourselves to the discovery of the uranistic child, to his development and the amelioration of his condition, if we encourage in him continence, chastity,

soberness, duty, we shall find ourselves in the presence of a new class adapted for celebacy, for study, for religion (since the realization of their desires is not of this world.) Like the ideal physician of Plato, the best of them will be of sufficiently weak character to understand the sins of their fellows, and of sufficient strength of will to make themselves useful.

Meanwhile (and this is meant for those who think that every Utopian scheme is vain, and they would not be wrong if such uranists had not always existed) the chastity of certain great men (whatever be the cause of it) has contributed greatly to civilization. The study and the furtherance of the education of uranists would have immediate results. Not only could many little beings now already begotten or wailing in their cradles be benefitted, but many new facts would be learned.

The causes of uranism (I speak of first causes) are probably as mysterious as those of the difference of sex; they probably do not lie within the province of our science, but we may be able to attain a knowledge of their mechanism, their ascendency, their heredity.

In the following pages I shall not attempt to study the prenatal causes of uranism, that I may not be embarrassed by hypotheses. After some observations which have appeared in the Archives d'anthropologie criminelle and which have been received with an interest very gratifying to me, I shall trace to the best of my ability (with some necessary digressions) the psychological history of a superior uranist under certain conditions, one who, however, begins his life enslaved by his vice; then I shall indicate my theory of sexuality; and I shall conclude by urging scholars, teachers and parents to attend to the moral education of uranistic children.

PREFACE.

Some Observations upon Inversion:

In my capacity as an observer and living much in the world, I have known many inverts and noted others. Their confessions, serious, sad, trifling, shameless—their lies and their

reticence, have taught me many things either generally unknown or neglected.

These are some of the observations.

The inverts are not at all content with the old explanation of the feminine soul in the masculine body. Some of them are more masculine than other men and are attracted to their own sex in proportion to the resemblance. They say that they despise women too much to be effeminate. Others think that similarity is a passion comparable to that excited by sexual dissimilarity. As men, they love men; but they affirm that if they were women, they would love women. These are the unisexuals par excellence. They are also the superior and the most interesting ones, they are perhaps the only ones who do not deceive either for the pleasure of deceiving or unconsciously. It might be admitted (and this would be a pretty general rule) that the more moral value a unisexual has the less effeminate he is.

It is an error to suppose that the unisexuals, the inverts, recognize each other. This is one of their boasts which has been often repeated; but one of their subjects of conversation is the very question whether this or that one shares their tastes, habits or proclivities. The effeminate of course recognize each other, but one may recognize them quite as easily without being himself effeminate. But prudence, self-love, pride, self-respect, a deep affection, a thousand sentiments, prevent a unisexual from betraying himself thus unless he is debauched or very effeminate. I think that the congenital inverts are less vicious and debauched, more honorable and estimable than most perverts. One may without much inconvenience (or even without any) be united by the ties of friendship with a congenital invert; but I have never found a pervert whose perversion was simply sexual. It is, however, possible that exceptional circumstances—isolation, or the influence of a remarkable and superior invert—should act upon an individual and invert him without great injury to the rest of his character. In this case one would not be aware of the inversion, for it would be limited to the relations with a single person, the superior invert, and it

might be at length refined to such a degree as to be unrecognizable and as for the inversion produced by isolation, it would disappear with this isolation, or if it persisted, it would remain absolutely sexual. It is with the congenital invert that the inversion is most often absolutely sexual. The born invert is accustomed to his character, his inversion is not acquired from vice or weakness or vanity or the love of gain or imitation or cowardice or fear or from the desire to win over some one who is necessary or useful, which are all causes of perversion.

The physicians who try to cure inverts have not sufficiently noted the dangers to which they expose their patients. They may transform their invert into a pervert. I do not think much of permanent cures of the sexual sense. Every imperfect cure may make of an invert a pervert; and if the invert is dangerous and contagious, the pervert is much more so. He has more points of contact with the normal young man; he startles him less, he takes less complete, though easier, possession of him than does the invert. The men who have seduced, corrupted and defiled the souls and lives of their younger companions are usually perverts. They have not always been unisexual. They have more power. They are more vicious. The unisexual who attempts bisexuality is as corrupt as the normal sexual man who attempts unisexuality; they have all vices, both those natural to them and others. Let the medical healer remember this before undertaking a congenital invert. Rather than to add the vices of the normal man to the abnormality which he has, the superior invert (it is he alone who would have a strong desire to change his condition; the inferior inverts find adequate satisfaction all too easily) should try—under proper direction—to lift himself above himself and his vice. The tendencies of our time, particularly the prevalent contempt for religion, make chastity more difficult for every one, and the invert suffers more from this than others. Instead of debasing the honorable invert by making him run after prostitutes and subsequently to become the unfortunate husband of a less fortunate wife and the father of children who will suffer as much as he or more, the attempt should be made to occupy and interest him

and to show him the horizons which he can attain by dint of effort and of will. If chastity were a virtue in better favor I should commend it to the physicians as a more effective remedy than to send the invert to a "puella" to prepare him for marriage and paternity. It would be better not to increase the number of husbands and fathers who are inverts or perverts. Instead of pointing out to the invert the normal state, which is for him an impossible goal, he should be made to hope to attain one day a state far above the normal. But how is this possible without honoring chastity a little more? As for the invert who wishes to marry in order to have children, his desire is almost criminal; if he marries for social convenience, to reinstate himself or to please his family, he ought to marry a woman older than himself, a woman of the world, who understands everything and accepts the situation. Even then the future is very uncertain.

The women of today are interesting themselves a great deal in masculine unisexuality. A great deal is said about it at present; the women are very well informed on this subject, not only the unisexual women (who are all accomplices of the unisexual men in all degrees from platonism to abjection), but also honorable women.

The women have contributed not a little to the unceremoniousness of the masculine unisexuality of the world. Arrived at a certain age, the women who no longer attract the attention of true men turn to the unisexual men who pay them attention for the sake of effect. Thus it is that inverts and perverts, who ought to be shut up in the insane asylums or penitentiaries, enter society and are there centres of infection.

I have sometimes asked myself if the serious writers who have treated of sexual inversion should not possibly be a little more reserved and prudish and not quite so innocent. They have all successively described the practices previously described by Martial and Petronius and boasted of by Verlaine and

Platen. In Latin, in German, in French, more rarely in English, with circumlocutions or without (but, alas! not frankly and simply), they repeat, one after the other, the habits which have always been known to the inverts, the perverts or the well-informed. I think the time has come for this to stop; and I imagine that the readers of scientific or psychological works can dispense with a detailed report of vices which upon the whole are rather rare. The plurality of homosexual vices once established (this has been necessary in order to establish the comparative rarity of sodomy, technically so-called), I do not see that science gains by their repetition. I should not complain, possibly, if inversion or perversion were treated with less frankness. The writers and their readers are so little conversant, it would seem, with very wide-spread vices (which, too, are spreading more and more) that they can neither understand them nor speak of them without apology and reserve. Why not speak of that which they see with their own eyes instead of recounting the errors of their predecessors or the indecencies discussed by them? If they cannot or will not see for themselves if they lack sufficient penetration or courage, then why attack so important a question which requires a penetrating scientific insight and a knowledge of the world as it is? Men of intelligence, excellent I have no doubt, seem to me to slip over this ground superficially and almost all in the same way. Have they really known or identified inverts or perverts? If not, they ought not to talk of them. If they have known or identified them, why do they not help them on a little?

Notably in Germany and Austria, Moll and Max Dessoir (who has contributed so much to the *psychology* of sexual inversion) and Krafft-Ebbing (author of the vast Psychopathia Sexualis, a valuable book which, however, brings together again rather too many of the falsehoods of that most deceitful race, the inverts and perverts) are free from this reproach. But Krafft-Ebbing seems to me to put too much confidence in the protestations of his patients. It is natural that the inverts should be eager to win over to their cause a man of the reputation and merit of Krafft-Ebbing, and it is easily comprehensible

how his kind heart and his loyality to the race might mislead him more than once. I do not think that the inverts are to be pitied as Krafft-Ebbing conceives it. If they are superior inverts, they suffer only what superior men always suffer. The strife between conscience, the propensities, prudence and the world is no worse for the superior invert than for the superior heterosexual man. Let us pity superior men if we will; but the strife against the passions is about the same whatever the passions may be, and we may pity the striver if he is noble. As for the ordinary or degraded inverts, they are no more to be pitied and they no more expect to be pitied than drunkards either from taste or habit or than the inveterate patrons of prostitutes.

I shall return to this point later. If the reader wishes to get some idea of the confusion which reigns among the authors, I will cite the great work of Dr. Dallemagne, Dégénérés et deséquilibrés. Not to retard my progress or cumber the ground here, I refer to the second note at the end of this paper. I hope that Dr. Dallemagne, who cites me without criticizing me, will not acuse me of ingratitude; I criticise him as the most recent writer and certainly not the least serious.

Persons are born more or less inverted, or they may acquire it either during that period of sexual indifference (so subtly studied by Max Dessoir) which lasts beyond puberty, or perhaps long after. Circumstances, isolation and its concomitants, bad examples and bad advice, reading and conversation, a young and passionate seducer or a prudent, adroit, and experienced one, disgust with heterosexual sexuality, disease, transitory or permanent psychoses, vanity, cupidity, or even necessity may transform a heterosexual into a homosexual.

With the congenital invert the inversion manifests itself very early. We should have thorough knowledge of that of which as yet we know so little, the sexuality of childhood, so as to know whether the heterosexual tendencies really develop so much more slowly or whether they are not observed when met. Before affirming that this sexual precocity (precocity of feelings, not acts) is a sign of the degeneration of the inverts,

account should be taken of the proportion of sexually precocious heterosexual children. How many little boys, how many little girls, form attachments for each other or for adults? How many little boys of five years are enamoured with a beautiful woman or a grown-up girl? People laugh at them and repeat before them that which they think about so mysteriously and express so comically and the little ones in the end explain to themselves the motives for their sentiments.

And certainly these sentimental affections are not rare with children. They are foolishly encouraged because they are amusing; but as these affections when they are homosexual are not amusing, they receive no attention. The child understands all this obscurely; when he gives some sign of the emotion produced in him by the presence or the contact of a man, he perceives that his agitation passes unnoticed. When he gives a flower to a woman people joke him; when he puts his hand in that of a man they say nothing. The man interests him much more than the woman and the grown persons think the contrary. The child devines very quickly that there is a misunderstanding there, and with the marvelous dissimulation of children he accepts the situation. Children are so dissembling, not only from ignorance but still more from fear and prudence. They know very early what they ought to say and especially what they ought to conceal. Science ought not to be surprised at this, for it exists to a certain degree among the domestic animals. Vanity and love of approbation are characteristic of children as of animals.

It is natural also that the congenital invert should recall so clearly the precocity of his propensities. There arrives a moment in the existence of every invert when he deciphers the enigma of his homosexual inclination. It is then that he reviews all his memories and in order to justify himself in his own eyes he remembers to have been what he is from his earliest infancy. Homosexuality has colored all of his young life; he has thought of it, dreamed of it, pondered over it—in perfect innocence very often. While still very small he has imagined himself kidnaped by brigands or barbarians; at

five or six years of age he has dreamed of the warmth of their breasts and naked arms. He has dreamed that he was their slave and has loved his slavery and his masters. He has not had a single grossly sensual thought, but he has discovered his sentimental bent.

The well-born congenital invert may be exceptionally innocent physically up to the age of puberty if he has no bad counsellor and if he is shy and ignorant of his own bodily structure. His depravity is then strictly cerebral and sentimental. It is not as yet applied to the surrounding persons. He loves the paintings, statues, and pictures representing pretty figures. Workmen, however, interest him on account of their garments, which differ from those worn by his parents; and he already experiences that passion of the invert for everything which resembles a uniform or a conventional costume. That which the Germans call *soldaten liebe* is so widely known and so widely practiced among the inverts and the corrupt in all the European countries that in certain towns the number of soldiers who prostitute themselves is larger than one would like to suppose. It is not an exaggeration to say that in certain regiments the presumption is in favor of the venality of a majority of the soldiers. The clientele must be numerous and assiduous for such results. The soldier is the craze of many inverts and the soldier as soon as he finds himself alone or with another soldier tries to allure his client by his looks and his bearing. His coquettish and trim clothes are not without effect. This is deplorable and painful and we may well wish to find a remedy for it, which is, however, impossible at present. Shamelessness and venality can be pushed no further.

While still young and pure the child feels himself ready for anything mysterious. He has heroic dreams. He is a hero loving another hero, and his waking visions are as fervid as any fairy stories. He is either the hero or the chosen friend or even more rarely and for a short time the heroine of the romance which he reads or hears related. The invert from birth is not necessarily effeminate; he is not always so, and he does not always prefer little girls and their games.

It is well to remember that the effeminate inverts are the best known because they have much the greater passion for confidences and for boastfulness. The inverts who hold their peace have not yet been found out and Krafft-Ebbing does not put them upon record. They exist nevertheless and they are the ones who prevent us from despairing for the race of inverts. Without them the vices of the woman added to those of the man would be a spectacle too disheartening.

It is difficult to do justice to the inverts ; so also it would be difficult to do justice to the heterosexuals if we were to confine ourselves exclusively to their sexual life. Falsehood and sexuality are always so intimately associated because reality belies desire since expectation and realization are in glaring contradiction. If men were bold today, if they were not under the sway of an all-pervasive materialism, how differently would they think of sexuality !

The invert thinks himself sufficiently disinterested to judge of the baseness of sexuality—but he has not the courage to go to the limit and to aspire to chastity ; he invents arguments in favor of his own propensities. If he were the superior being that he imagines himself and if he had any religion, he would shake off the bonds of the flesh and make himself useful to humanity. How much celibacy and continence can do for an invert they only know who are not materialists.

The day when the invert ceases to call for the indulgence of society, he will begin to justify himself in the eyes of truly superior men. Because heterosexuality is not suppressed homosexuality ought to be equally favored. Strange logic, if the repression of heterosexuality is one of the problems of the future, as I believe it to be.

Along with this romancing, this platonism, these fervid stories, the child feels a carnal attraction for the man and he does not yet know, perhaps, that the two thoughts which interest him are related. Every day the child may seek for opportunities to touch the hand or the body of a domestic, at meals, for instance, or on the stairs ; and every day the same child may dream of the most innocent and fantastic careers. This

inconsistency is common with both men and women; with men it is especially objectionable. It terminates in hypocrisy, in weakness and in uselessness. Virtues apprehended by the intellect merely, not by the will, cannot effect a cure. They often do more harm than good. Fair speech and thought with a corrupt life do more harm to young men than shameless debauchery. He should not say too much about the ideal of chastity and purity, for chaste words from a profligate seem too much like the lassitude following the debauch to the eyes of the rude, the young or the scoffers.

The inverts follow out this inconsistency to its extreme. For the most part there is a total difference between their theories and their conduct; they have propensities so etherial, they are so conscientious (in their own estimation), and their gratifications are both imperious and easy. When alone they are siezed with sudden desire or they even seek out from time to time a young and compliant friend, a friend more poor than themselves, often one who who is married. These inverts are not the worst. Their hypocrisy may be feebleness. They pervert others but little after their earliest youth. They have some regard for their dignity. They are not chaste, but they are not libertines. A young man might be entrusted to them without danger. They do not spread the contagion. They are solicitous of their honor and their reputation. Some succeed in conquering themselves after a fashion, in overcoming their youthful errors, and if they pass the crisis, which is as frequent in the man who has settled down as in the chaste woman, they may die respectable and respected.

The inverts not having chosen their own nature should be credited with the desire of improving and purifying themselves; and if we should assert the superiority of the invert who *restrains himself* over the heterosexual man who abandons himself to his sexuality, this would be nothing more than justice.

The child (to return to the poor being) probably feels for the domestics in livery or in their shirt sleeves the first touch of that obsession of the uniform, an obsession which occurs in the sexual life of the heterosexual. How many men love the

woman clothed or half-clothed in a certain fashion. Most men love a certain type and everything which approaches to it in carriage or aspect acts upon them more rapidly and violently. Often after an infidelity to their type they return to it with the more servitude. Men have but little imagination. Some of them with all their conquests, whether of women or men, make the same pilgrimage, go each time docilely to the same museum, to the same place in the environs of the town, etc., etc.

The difference between the classes is under certain circumstances almost tantamount to that between the sexes. It is very possible that this observation which I have often had opportunity to make will explain the sonnets of Shakespeare. An enthusiastic friendship (a passion which involves neither inversion nor perversion) and the social distance between Shakespeare and the young man, and the youth of one and the ripe age of the other might give the clue to the enigma. The inverts and perverts comprise so many celebrated men and so much glory that they may give up Shakespeare.

The child escapes none of these influences. His parents have forbidden him to associate familiarly with common people; and the laborer, the valet, the butler, the coachman, seem to him the more attractive. If the child is ill and if he it carried by one of these men, his heart beats with fear and pleasure before, during and after it. He compares these sensations with those which he experiences in the arms of his father or a brother and the difference is so great that the child cannot be deceived about it. He admits it. He does not know why. He conjures up some explanations. He begins by thinking that such or such a man pleases him. But it is not a man who pleases him, whose embrace enraptures him, whose touch tumultously excites him; it is *the man*. When the child has so far surmounted his ignorance as to arrive at this knowledge of himself, his sentimental education progresses of itself. The child furtively gives way to a host of impulsive acts to attract the attention of the man who interests him, without being suspected

by his family. An amorous woman is not more foolish and more prudent, more patient and more impatient.

These manœuvres may continue several years before, during and after puberty. The child sees more and more clearly his desires take definate form. At first he does not know what he desires—some sort of contact, a kiss. Greek history then informs him that Greek men loved each other; that the Greeks were beautiful, noble, admirable, that Greek love is not approved of by present customs, that Socrates and Alcibiades slept under the same mantle, etc. It needs no more to excite and fill the imagination of the child. "I am then an ancient Greek," he says to himself. He rather looks down upon the moderns. He is still too far removed from modern life to be uneasy about his inversion. On the contrary, it interests and occupies him.

At college the invert *may* remain innocent, while the heterosexual may be trained there in a more or less permanent way for homosexuality. The influence of the boarding school is a very important matter and one very difficult to fathom. All—or almost all—whom one questions and who will reply are probably far beyond or far under the truth. The inverts, for example, are either very reticent or very boastful. Many of them have a craze for seeing their kind everywhere. The heterosexuals who are not smitten with the passion for gossip would probably deny it shamelessly from cowardice, shame, indolence, or what-not. The masters, as may be easily conceived, can neither tell nor see the truth in this matter. If it is easy in the prisons, to indulge in unisexuality, the vicious or inverted children are no less ingenious than the prisoners. The very vicious at college are often inverted only by vice without any other occasions. Children may debauch themselves without for that reason being inverts. Many inverts have an exaggerated modesty which may shield them, though the dormitory life is inimical to modesty.

It is well to remark here that if any one observes in little boys an instinctive modesty, especially in the presence of a man, he should be mistrusted. Are we in the presence of an invert?

The inverts when they are very small show all the signs of modesty before one of their own sex. This modesty, unless eradicated at college or concealed from prudence, persists throughout life. They are extremely boastful when they begin to overmaster it. After they have madly given themselves up to unisexuality they lose that modesty and prefer rather the contrary. The modesty of a woman of bad life is not that of an honorable or delicate and high-minded woman.

I have not sufficient material to study the question of dormitory life. The tales and confessions of inverts are upon this subject worthy of little credence. Inverts, as I have said before and shall again repeat, are liars, and in speaking of their childhood they seek to exculpate themselves or to make themselves interesting by virtue of their passion and ignominy.

I shall only remark that certain children are not interested in the other children. They may thus pass through the boarding school without being attracted to their comrades of their own age. They love either the big boys who most of the time do not pay any attention to them or the domestics or the masters. It is evident that these children would never be in danger. Their affection for their masters would almost always only fortify them in their desire for study. They are the children who do not regard themselves as children. In their dreams they are already great persons.

Other inverts as is well known, always love some one (or ones) of their own age. They are *the* homosexuals. They have the passion of similarity. They are perhaps among the less effeminate. I should like to emphasize this fact: the inverts cannot be effeminate as the effeminate can be heterosexual. It is probably easier to pervert an effeminate person than to make an invert effeminate.

The licentious, vaunting or diseased inverts have had the honor of so much publicity that the others are as yet little known. These attain an intellectual and moral maturity without considering sex the pivot of the universe. They have nothing to complain of in their lot. They have to fulfil their mission here below and they do their best. There are also

some heterosexual men who break away from their genital life at some period of their growth.

It is an error (which the writers on inversion tend towards) to suppose that the inverts are necessarily wayward, or deranged or bent on indulgence with some compliant individual. Many heterosexuals if they are in good health are not always thinking about women.

As puberty approaches the peril of the invert increases. If he is a day pupil or is being taught at home his ignorance and anxiety are put into a ferment. Every accident now has its importance. He is probably ignorant of the physical side of the sexual act. He imagines perhaps that the relations among men are like those between women and men ; he knows, however, that the realization of his desire will be sterile. He may be sufficiently mature for the sexual act and thinks that it consists in a superficial contact more or less prolonged.

If any man, especially a man of the lower classes, as a domestic, is thrown into the company of a young invert, this man becomes the fixed idea of the child. I say the child, for at 13, 14, or 15 years, a boy trained in this way is a child. The young boy will contrive every day unexpected meetings with this man. He knows the hours of his duties and will put himself in his way several times a day if possible. He tries especially to meet him in the dark in order to feel the contact of his body against that of the man or to take him by the hand. Though previously modest, he will contrive occasions to show himself nude or semi-nude.

I do not know whether it is instinctive or whether it follows from the tales of feminine seduction which he has read, but he acts like a shameless and amorous woman. Such perseverance will sooner or later be duly rewarded and some gloomy afternoon or some dark night the man will yield to the audacity of the young boy.

Here again the details and the consequences of this downfall will all depend upon chance. The inverts who read this and the medical psychologists will acknowledge the truth of what I have written, though the family may not even know

that such things have taken place or are taking place before their eyes. Such liaisons may be developed and protracted for a long time, the audacity of the child in the first lascivious flush of puberty overcoming the scruples or the cowardice of the man. The difference of rank here takes the place of the difference of sex. The man of the people allows himself to be led by a young *gentleman* when he would perhaps oppose a young boy of the lower classes. If the man is an invert or a pervert or very rough he asks merely an initiative from the young *gentleman* to be enchanted. If he is none of these things it should not be forgotten that the degradation or the subjection of a son of his master or patron can only flatter a man of the people and avenge his own servitude. It should not be forgotten, too, that service may develop such a habit of obedience that the domestic may submit to the caprice of his young master with or without pleasure, for better or worse.

It is possible that in many cases a man who hunts up a young boy with the intention of seducing him may succeed only in frightening him. Many inverts have been frightened in their youth by the desire of a man without morals and without conscence and have escaped from his caresses seized with an incomprehensible terror either trantient or persistent. It would be only the invert born for passivity and feminine pliability who would easily allow himself to be violated or polluted or instructed by any man, There are some virgin women who give themselves up who would not permit themselves to be seduced. So also the virgin and masculine invert (there are some inverts who are rather a male and a half than a half effeminate male) might well offer himself and lend himself to all the delight and all the baseness while he would betake himself to flight if a man should take the initiative. This would explain many of the histories of inverts and many of their refusals and consents.

So far we can only pity or deplore the conduct of the young invert. He has all the excuses of his nature and he has had no advice, no assistance. He knows that his conduct would be execrated, but he does not consider himself any worse than the men or the women who are attractive to each other

and love each other. He justifies himself with the thought that these are the sexual pleasures which are called by the name of love and which according to the poets, the cynic moralists and the romancers rule the world. Being naturally homosexual, he does not see any difference between his vice and that of the heterosexual; and not finding heterosexuality treated as it ought to be, that is without too much indulgence or enthusiasm, his conscience does not trouble him. It is only in learning to break down or despise or to surmount sexuality and sensuality that the congenital invert can turn away from homosexuality. He takes to himself all the excuses which there are for heterosexuality and adds to them that homosexuality is sterile, etc.—about what Schopenhauer seems to have said in favor of pederasty.

I am not here concerned with pederasty and pederasts, of whom too much has already been said; but I would remark that the distinction between the pederasts and the inverts not pederasts is not so absolute as people have recently (and in the interest of the inverts) tried to show. The horror of inverts for pederasty seems to me a little exaggerated. It is rather too much like the pretence of modesty when none is left.

But after all, since this is the only way perhaps to keep the inverts under law and penalty, we accept this assertion. In all cases sodomy, technically so-called, is not by any means necessarily the end of the sexual life of the invert; but it is certain that some inverts love either to practice or to submit to sodomy. I understand how the students who have desired to rehabilitate the inverts may be unreasonable upon this subject; but I believe that the truth is not as absolute as they affirm it. And, too, they sometimes contradict themselves. I am altogether of their mind if they wish to maintain that the pederasts are the off-scouring of the earth and the most bestial. Physically they are puny, I imagine—and they deserve to be so.

I have said that one could not blame the invert when he has first fallen; but if he is intelligent and if he has any strength, he can rise and retrieve himself. And it is not once in his life only that he falls; he will fall and rise again many times, and if

he has any strength he will not allow himself to be degraded by the errors of a youth without moral direction.

The superior invert has equal chances with the heterosexual and analogous dangers. He can grow up into a moral and worthy being such as a man ought to be, or he can sink into frivolity, luxury and falsehood.

This moral education will have cost him dear and if he has cursed the father who begot him and the mother who conceived him, as well as society which has misunderstood him, he will find himself some day superior to his jeremiads, and if he examines his complaisance this is what he will find: his complaisance and its moral and social value rest upon the check imposed upon his proclivities; I do not say upon the contradiction imposed upon his proclivities.

Inverts of the same grade do not often meet and they do not always love each other. Our invert has probably either loved only inferior inverts and now he has the same disgust for them which a frivolous and disreputable woman inspires in a sober and upright man, or else he has loved heterosexuals who were more or less attractive, weak and interested. In all cases his experience has not been very happy. If he has made conquest of heterosexuals of good character his victory has been difficult and of rather short duration, (if he has committed the fault—for him—of falling in love with a woman, it has not been for long), and he sees that sexuality cannot be the goal of existence for a superior person whether homosexual or heterosexual.

The great men claimed for homosexuality have been great only because they have not allowed themselves to be overmastered by their sexuality. The grand inverts have been grand in spite of their inversion or because they raised themselves above it and so above humanity. The man without family, without wife, without children, who is kept by continence or by chastity from so many annoyances, vexations and falsehoods and whose heart is not barren and withered, may be a Michael Angelo or a Newton. (Newton is classed here only for his chastity). The list of historic inverts given by Moll might be indefinitely in-

creased; it might also be revised. It does not contain, for instance the great Condé, the victor of Rocroy, and Moll cites many debauched and feeble princes.

Greece—but if the superior invert truly fathoms the history of homosexuality in Greece, he will recognize that the invert there was scarcely more fortunate than in Europe at present. The young man well born had to protect his honor and his reputation like a virgin of our day. The young men of today have more liberty than the young Greeks and they would find it intolerable to conduct themselves with such circumspection. Greece was not the paradise of the inverts. Far from it. Among exotic peoples whether north or south (for climate has no influence upon homosexuality, as is claimed), among the Esquimaux, the Annamites, or the Mexicans before the conquest, the inverts could perhaps satisfy their inclinations; but they perhaps also had to register in a class apart (as we see it among many peoples), having certain privileges and a paradoxical consideration.

The superior invert has no right to think himself born out of his epoch or his country. Even the Orient of today where pederasty is practiced without difficulty would not offer him the intellectual pleasures to which he is accustomed, music, the theater, etc., etc. He will see with a smile that most of the new Greeks would have been considered too sickly or too greatly malformed to be reared by the Spartans. He will see with more or less courage that the satisfaction of the sexual appetite cannot be the *sine qua non* of existence to a modern man, to a civilized man. Civilized man has enough other necessities; and when we speak of the injustice of fate and of society, when we ask for a different method of treating the inverts, why not think of other recognized and admitted injustices? For example, a young man, heterosexual, poor, hard worked, not able to marry and disdaining low and repulsive women, not having the means to give a more attractive woman that which she expects, neither able nor willing to be the paramour of a venal or wealthy woman, and not desirous of availing himself of adultery with all which that involves,—this man, from the sex-

ual standpoint has as much to complain of as the invert. Their situations greatly resemble each other. The best they can do and the most that is possible is to set aside their vanity and to say to themselves that the sexual act should not be the pivot of their existence. I say their vanity, for vanity and envy sometimes derange a man sexually and the idea that others have pleasures which he would like to have is a most powerful tempter. Krafft-Ebbing is the representative of those who claim justice for the invert, and I ask nothing better ; but it ought to be emphasized that his demand has as its basis the theory that every man has a right to sexual satisfaction. If one grants the right to heterosexuals, I do not see how it can be refused to the inverts ; especially as the refusal to them in no respect changes the condition of things. But in my opinion every man has not the right to lay claim to the sexual satisfaction of his desires. The same moral law which forbids the heterosexual who is epileptic or phthiscial or attainted with any transmissible disease whatever from perpetuating his scourge and transmitting it, this same law forbids the invert from yielding to his propensities.

The corrupter, man or woman, is the one who seduces another, whether man or woman ; he is one who diminishes the sum of purity or chastity in the world. The corrupter ought to be condemned. The infamous, abject being who lives upon the vices of other and encourages them, a source of moral and physical peril ; the being who extorts hush-money after having aided in the debauch, ought to be suppressed by the most severe measures possible.

The inverts in their biographies often say that they did not understand the cause their inversion. They have been in love with their friends, they were perhaps loved sexually, etc. ; then they had relations with women and little by little discovered that it was not a man whom they had loved, but mankind, that it was not ignorance which had kept them away from women, that their feeble attraction for women was not an accident, etc., but that they had always been uranists or inverts. Then they loved with terror, ardor and enthusiasm some soldier or other,

no matter whom, they struggled against their propensities perhaps, then they abandoned themselves to them.

All those who have read the works devoted especially to inversion will recognize the histories to which I allude. It seems to me that we ought not to lay too much weight upon these autobiographies nor to attach too much importance to them. If one were to collect the autobiographies of adulterous women, he would be struck with the resemblance,—the same logic, the same lack of logic, the same fierce egotism, the same remorse, the same apologies. And yet scholars do not ask us to exculpate and pity adulterous women from the fact that they are adulterous.

So I protest that we should not make a practice of pitying the inverts as inverts. The enthusiastic uranists do not wish to change. With whom should they? The true homosexuals, those who have the passion of similarity, if they were women would love women; so also the true homosexual if he were a man would love a man. Let us pity humanity as a whole if we wish; let us pity it bitterly if we have no religion;—but let us not pick out the inverts for the our utmost pity. I cannot repeat this admonition too often. The abject or enthusiastic inverts do not think that they are by any means to be pitied. The superior inverts are no more to be pitied than superior heterosexuals. As for the inverts who moan and lament and who beset writers with their stories, they are usually persons who would have moaned and lamented if they had been heterosexual. No one finds easily a person of the opposite sex who satisfies at the same time sex, the soul and society and the family. Why shonld the invert have that which the heterosexual finds with so great difficulty? How many heterosexuols are unhappy by reason of their sexual life? Syphilis, nervous disorders, disrepute, the dissolution of many bonds, as well as many other things, pursue the heterosexual who is unfortunate or devoid of character.

The individual who is neither chaste nor sober nor vigorous nor reasonable nor very courageous nor very enlightened nor very pious is always to be pitied whether he be invert or hetero-

sexual. The inversion of the great inverts may always be pardoned ; it does not hinder them from being themselves, from accomplishing their work in the work. Do we believe that Plato, Walt Whitman, Michael Angelo, the Great Condé, Winckelmann and the host of others deserve or desire pity for their homosexuality ?

Great men are great by reason of what they are, in spite of all the infirmities and the abcidents of this life. Men of genius, whether homosexual, heterosexual or indifferent, make it very plain that men are not to be classified according to their sexual bent, but for other considerations of a different order. If great men and men of large heart and lofty spirit find themselves outside the pale of the pity which people like to organize for the aid of inverts, ordinary men who are uranists and who are sick, degenerate, unbalanced, weakly, unfortunate, hypocrites, ought to be judged like the sick, the unfortunate, the feeble or the craven—but why excite our sympathy for them ? Read carefully their autobiographies and tell me frankly and honestly, would they have been worth any more, would they have been more happy, more virtuous, if they had been heterosexual and as prone to sexuality ?

As for prostitutes, extortioners of hush-money, adventurers, let us be just ; but not indulgent ! I speak of prostitutes of all degress of the social hierarchy. Even those who gladly sell-themselves and who love their business and their keeper are given over to the extortion of hush-money and theft. The man of the world who resorts to one of them knows what threatens him and hardly deserves the pity that would gladly be given him if one considered the consequences only of his folly.

The hypocrites or the cynical debauchees who try to deprave or who do deprave children, young boys or very young men are treated by public opinion with commendable justice and contempt. *This severity and this contempt ought not to be diminished.* The inverts often share this contempt and some of them avoid each other and criticize each other and spurn each other. This is less from sexual inappetence, I think, than because they understand each other and despise each other too much.

The effeminate inverts *sometimes* are like heterosexual women and are not attracted to each other sexually, but love each other with affectation and feminine caresses. It should be emphasized that the invert who is satisfied, satiated and fearless chooses the one or ones whom he prefers. He has lovers and friends. He may have for his friends short caprices or temporary connections, but they are not very often of any consequence.

There are some inverted collectors, like the heterosexual collectors, who have a passion for "recognizing" the greatest number of inverts possible. The uranistic physician consulted by Krafft-Ebbing boasted of having known 600 uranists. This figure will not astonish any one familiar with the number of debauchees of the world who seek each other out, and with the number of weak men who yield sometimes from curiosity, from impulse, from cupidity, from memory of childhood, from authority or from difference of age or rank.

Inverts have no illusions about each other, youth and the first ignorance once past; and those who have a passion for heterosexuals have it partly after the manner of women. Heterosexual men seem to them so superior, so sincere, so upright, so brave, so strong, so frank, etc. They adore in them the virtues in which they find themselves lacking, not because of their inversion by any means, but because they are deceitful, cowards, liars, feeble and faithless. People without integrity, whether men or women, are normally strongly attracted by those who have this integrity, and I believe that it is the insincerity and meanness of the effeminate inverts (rather than their inversion) which impels them to the search for a man without deceit and subterfuge.

The effeminate unbosom themselves to each ether freely, but this is only the flattery and politeness of women. There are some women homosexual and heterosexual at the same time. There are correspondingly effeminate men. There are some who are married and heads of families. They paint themselves as much as their wives or more. There are plenty of them.

The less prosperous and more eager inverts will love the

man or the youth whom they can. It must not be forgotten that many men are not in a position to choose. They love the man who is most convenient, most adapted to their situation, most accessible. They cannot gratify their fancies. They do not like to become intimate with a man of the people or with a boy of their own class who is still young and they content themselves with the sexual intimacy within their reach, though longing for some one younger or older. Many of these more favored inverts are not, then, more characteristic than those who can satisfy their caprice. One may find men and women, whose tendencies are heterosexual, of exactly the same kind. Many heterosexuals have not the person or persons whom they would have preferred, and yet they are content or else they learn to abstain altogether. Many heterosexuals by virtue of that which we ironically call good fortune have utterly transformed, tainted, corrupted, themselves. They have vices analogous to those of homosexuals without force of character. All seducers are alike. If people did not always stop at the superficial differences between man and woman, if they would look a little deeper, they would understand that the homosexual and the heterosexual are not very different.

I am now ready to make this assertion which at the first blush may seem a little paradoxical: *There is no line of demarcation between the heterosexual and the homosexual.*

Between the degraded homosexual and the low heterosexual there seems to be a sufficient distance, and yet they lie very close together. So also the homosexual of high worth and the heterosexual of equal rank come into very close relations and can hardly be distinguished. The man who allows himself to be dominated by his sexuality and by that of others is sexual before he is uranistic or heterosexual. The man who is above his sexuality can without danger to himself or to others be either homosexual or heterosexual.

It is not only the extremes which meet here. There are some heterosexuals (as is recognized by all writers on inversion) who are very effeminate, very affected. The heterosexual may even paint and prink and mince along and imitate the graces of

the woman, the voix fardée (to use the happy expression of the sixteenth century poet; see the third note) and the feminine motions. He may spend his time upon his toilette, upon his person, in gossip, small talk and slander, may be timid, without originality or opinions of his own, etc., and yet have sexual relations with women, neither having nor ever having had any others. I challenge the observer to show me a homosexual who does not correspond to a heterosexual. I undertake to find a heterosexual corresponding to every homosexual.

Diderot explains homosexuality (if I remember correctly) by scarcity of women, thinness of blood, fear of infection. These causes are ingenious, but they are secondary. In the prisons, colleges and barracks the lack of women, together with the presence of males, encourages the uranist, tempts the heterosexual whose principles are not impregnable and leads astray the indifferent, whose sexuality depends upon circumstances. If we were more familiar with the laws of heredity we might affirm that the children feel the effects of this encouraged, tempted or errant homosexuality, but we do not know whether uranism alone is transmitted or whether acquired inversion is also transmitted.

One thing is sure, but like everything concerned with heredity it is a matter dificult of explanation,—there are some families where inverts are numerous, where the father and the sons, the uncle and the nephews, or the brothers are conspicuous for their inversion. A noble English family has recently been represented by two brothers (one of them married) in two of the most notorious unisexual scandals. The father has a totally different reputation. The scarcity of women does not satifactorily explain uranism, though it may develop it; but how many men have passed through all these conditions without becoming homosexual, how many have been able to give up the madness caused by the desire for that "Y grec de chair" of which a novelist has eloquently spoken in an attack upon the military prison system (Birbi by G. Darien) and have returned to civilization as heterosexual as before?

We too often forget that (if we exept those whose impo-

tence or aversion has a psychical origin) heterosexual or homosexual acts do not determine heterosexuality: many persons from conscience, from circumstances, from vanity, from weakness, etc., give themselves up to or engage in acts which do not correspond to their true sexuality, their ordinary or normal sexuality. We ought not then to judge of the whole of a man's sexual life by his isolated acts. Marriage, mistresses, and *la bonne fortune* will now no longer be sufficient to restore the homosexual; they will scarcely avert suspicion. It is the same with paternity.

Love of beauty acts homosexually only upon the uranist or the libertine or the rare visionary who is not enough of an artist to respect beauty. I think we can separate love from beauty. The uranists who should represent themselves as carried away by the love of beauty would be rather blasphemers or sophists. Beauty, so far as it is supreme beauty hardly carries with it any sexual excitement. It is, then, not beauty which excites them. It is more correct to say that certain uranists justify themselves after the mischief is done in their own eyes by the superiority of the lines of the masculine body over those of the feminine. The artistic or trained heterosexuals have no idea of this and they none the less remain heterosexual. If perfect and abstract beauty did excuse this madness of the senses, I should think that art would be sick indeed. Beauty inspires a certain respect in souls well-born. If love of beauty leads to inversion, it leads quite as much to heterosexuality, or rather it makes no difference which sexuality makes beauty one its attractions.

Hereditary weaknesses lead wretched men to all kinds of baseness, all vices and all bad practices. How many hunchbacked, lean and sickly men adore large handsome women?

The fear of disease alas! only rarely restrains men; the circumstances must be very peculiar for a young man to allow himself to be controlled by this dread. I should rather think that in many cases this is an excuse, especially as some terrible diseases may be transmitted by homosexuals; cancer of the throat and palate, for example, cannot be rare among them.

If I say that there is no line of demarcation between the homosexual and the heterosexual I do not really contradict the title of these observations: Uranism, or congenital sexual inversion. To explain: some men are born uranists; they seem to be predestined for uranism from their earliest childhood. It seems to me that nothing can change or unsettle them. They have perhaps fostered this predilection of theirs, they have trained themselves up in it, and nothing can turn them from their path. Other men are born heterosexual. They are predestined to love women and nothing will prevent them, neither strict education nor the career which they enter. They have for inversion only the most profound disgust, the greatest abhorrence. Other men (and I wonder if they are not as numerous as those in the preceding category) are born indifferent. They are found in all grades between absolute homosexuality and absolute heterosexuality. We should find complete psychic hemaphroditism, the man-woman, and several varieties of man-woman; there would be the man who is masculine with reference to men and to women, he who is so with reference to one sex (no matter which) and not to the other. There would be found all possibilities, all improbabilites.

Education, moral and physical circumstances, friendships, the influences in operation, every occurrence, great or small, slowly determine the form the sexuality of the growing child will take. The childish affections are stamped with this sexual uncertainty. They show us, what we shall do wrong to forget later, that the affections may be powerful and yet pure. If nothing impedes the development of the child, if he is surrounded by persons who unconsciously guide him toward heterosexuality, he will become a man like the majority of men. On the other hand, if those who surround him in one way or another unconsciously direct him from heterosexuality by isolating him, by making him early familiar with all that may be said against women, by holding him down to too strict and rigorous conduct, he will incline more or less toward homosexuality for a longer or shorter time. Everything will depend or circumstances.

Those who are indifferent, who may develop homosexually or heterosexually with almost equal ease, are often guided by the restrictions imposed upon them or by the liberty permitted them. If they find it impossible to form a union with a woman without irksomeness, restlessness or reproach, they will the more easily fall into homosexuality. If education (often ignorant of what it is doing and preparing for) and if the thousand chances and accidents of life act in so different ways on so many men, what shall we now say of absolute homosexuality, of uranism and of absolute heterosexuality? Shall we not change our point of view a little without giving up the notion of Uranism, or congenital sexual inversion? The uranists and the prococious and rabid heterosexuals *have never had a chance.* This is my theory.

No one has any doubt about their tendencies or their destinies. No one has done anything to divert their sexuality. The attempt has been made perhaps, and that much too late, to subdue their sexuality, but what has been accomplished against homosexuality? Nothing.

The most precocious little heterosexual might be rendered psychically hermaphrodite by an education adapted to his case; and the most inverted little uranist might also be rendered psychically hermaphrodite, that is to say, more like the heterosexual, if we knew how to train our children or those of others. The heterosexual child does not concern us here. What does concern us is to indicate, or to try to indicate, what education can do for a uranist.

Before all, how, by what signs, is the uranist to be distinguished? I would appeal to all those who have devoted themselves to the education of children or who have known uranistic children and beg them to recall the indices given by these children and by their parents.

I have already spoken of the precocious modesty of the inverts. This is a sign to be noted. Are the children ashamed in the presence of a man; do they hesitate to undress or to show their bodies in the presence of a man in order to satisfy even their most elementary needs?

This is a sign not to be neglected. The prudence and reticence of children renders very difficult this important task. Precocious and exaggerated modesty cannot be the only sign of infantile uranism. But where shall we find what we are looking for?

Uranists often relate that they loved the games of little girls; but many heterosexuals have played with dolls because they had good imaginations, and have done needlework because they had nimble fingers. Precocious vanity and a taste for finery should rather be feared. This ought always to be discouraged, though not in such a way as to make the more interesting that which is forbidden. All masquerading should be avoided, anything which would give the child the illusion of being a little girl. There are some parents who dress their little girls like the boys from stupidity and ignorance. Everything which accentuates or tends to confuse the notion of sex for the child is to be feared. I have often found—though I would not wish to be accused of making too wide a generalization—a uranistic brother with a sister more or less inverted, or a homosexual sister with a brother more or less suspected. I have many times been struck with this coincidence, but I do not know how to explain it. If the brother and the sister have been together during their infancy, one might attribute much to their reciprocal influence. The delicate and feminine brother would bring out all that was masculine and energetic in the sister. She would get into the habit of protecting her brother and of supplying those qualities which he lacked. Those conversant with the psychology of children will appreciate what I have just indicated. But after all there would have to be (in order to explain the kind of companion the one is for the other) in the case of both brother and sister a predisposition or a degeneration.

Uranists are precocious and precocity ought always to be guarded and given the food of which it has need. Love of pretty things, of dress and of objects of art should make us watchful without leading us to discourage them. On the contrary the predilection for the artistic has aided more than one

uranist to lead a possible or respectable existence ; only this predilection should receive this most serious possible attention that it may not become a bent for mere amateurism. The uranists are often very superficial ; amateurs of all kinds are recruited from them.

Many of the arguments used in favor of women may be employed in favor of the inverts. If one speaks to a defender of women of their intellectual inferiority and lack of loyalty, he will say, they have never had a chance, they have never been taught any of these things.

Well ! since the invert is not burdened with maternity nor by all the vexations of the female sex, why not try to make him serve humanity? He has many defects and many vices inborn, but our civilization and our education do not and cannot improve his condition.

The bees and the ants have workers who do not reproduce. Is it possible, barely possible, to make some use of the uranists ?

NOTE I.

Et pour combler leurs voeux, chacun d'eux tour à tour
Fait l'action supreme, a la parfaite extase,
—Tantot la coupe ou la bouche et tantot le vase.

Dormez les amoureux ! Tandis qu autour de vous
Le monde inattentif aux choses délicates,
Bruit ou git en somnolences scélérates,
Sans meme, il est si bete ! etre de vous jaloux.

—Verlaine : Parallèlement, Page 99.

Lass Wang' an Wange heir uns ruhn im Düstern,
Und Brust an Brust gedrängt, und Hüft an Hüfte.
Horch ! wie es saüselt in den alten Rüstern :
Durchschwärmt vielleicht ein Elfenchor die Lüfte,
Wollüstig weichen Brautgesang zu flüstern.

Allein im Stillen völlig sich beglucken
. . . . wechsolseitig
Umfassen sich mit ruhigem Gewissen ;

Um nichts Besorgniss hegen anderweitig,
Und hoffen, nie was man gewann, zu missen,
Dies Glück ist mein, das macht mir keimer streitig.

—Platen.

NOTE 2.

Doctor Dallemagne (Dégénérés et déséquilibrés, 1895) cites Moll and translates him thus (page 505):

"Les uranistes qûe j'ai connus appartenaient aux professions les plus "diverses. J'en sais qui sont avocats, médecins, théologiens, philologues, "commerçants, officers, écrivains, acteurs, tapissiers, coiffeurs, et meme, étrange "ironie, tailleurs pour dames. On comprend du reste pourquoi les uranistes "affectent le métier de tailleur pour dames, ils y remportent de nombreux "succes dus à leur voix de fausset et à la grace avec laquelle ils exécutent les "mouvements feminins."

Doctor Dallemagne finds this explanation far-fetched. The making of breeches he says jocosely, would be more intelligible. Is he ignorant (that seems impossible) of the passion of many effeminate persons for the feminine toilette? The tailors for women probably imagine themselves wearing their own creations and turning the heads of all the males.

On page 507 Doctor Dallemagne, who treats the inverts as if they were savages newly imported and never before seen in Europe and who cites the very interesting, sober and estimable work of Moll as he would cite an explorer, says

"Vous savez que la dénomination d'uraniste contient à la fois l'agent actif et "l'agent passif. Mais, en réalité, le véritable uraniste est l'actif: le passif est "rarement un inverti et dans ce dernier cas il intervient par complaisance "plutot que par vocation, a charge de revanche si vous voulez. Le passif est "parfois un mercenaire, mais cette circonstance constitue, parait-il, une réele "exception."

I think that those who read these fine-spun phrases from a weighty volume of 658 pages will pardon in me some expressions approaching conceit. If men of science collect details so erroneous, if they are so ignorant of what every psychologist might know; of what classical antiquity already knew so well, my criticisms and self assertion will be pardoned. It is inconceivable that any one has read the principal works upon inversion and is ignorant of the passion of many uranists for passivity, a passion which impels them to the acts so often expressed in Latin.

NOTE 3.

The literary citations of the writers upon inversion have so little variety that the reader will perhaps allow me to present the following sonnet. I find it in the journal of Henry III by Pierre de l'Etoile and it forms a part of a collection of poems and satirical works published against the king and his favorites in 1577, 1578 and 1579.

Je me ris quand je vois de ces jeunes guerriers,
Marchans au petit pas, la facon effrontée,
Qui d'un brave discours et d'une voix fardée,
Desfont un escadron de mille pistoliers.

Je me ris, quand je vois ces rudes chevaliers
Et tous les Adonis de la belle chambrée
Se promettre l'honneur de conduire l'armée
Ou bien un régiment de chevaux—lègers.

Mais je rirai bien plus, quand, venant aux effets.
Je les verrai souvent ou battus ou desfaits
Revenant au logis plus doux que des pucelles.

Alors je leur dirai : Mes mignons de la Cour,
Retournez a Paris, qu'on vous face l'amour,
Frizants vos beaux cheveux comme des damoisselles.

The epigram by St. Eustace upon a young coxcomb will not be out of place here.

Peu de jours a, qu'en ceste ville
Un jeune mignon, bien pégné,
Bien fardé bien goldronné,
Espouscit une jeune fille.
Le vicaire, homme fort gaillard
Leur dit, Vous avez tant de fard,
Vous avez tant de passefillons,
Les cheveux si crespus et blonds
Que je ne scay pas d'entre vous
L aquelle est l'espouse ou l'espoux.

24 Juillet 1576.

I am enabled by the kindness of a poet to present a translation of the two French poems :

I laugh to see these pretty warriors,
Their dainty gait and air of insolence,
With painted speech who make such brave pretence
To put to flight a company of horse.
I laugh to hear these hardy men discourse,
Adonises of the mess-room, yearn get hence
To action ; and their martial wrath incense ;
Lead regiments—light cavalry of course.
I shall laugh more when having come to deeds,
I see the broken and disheveled heads

Come back, as modestly as little girls'.
Then I shall say: My courtly gentlemen,
Back to your Paris, to be loved again;
Sweet damsels, run get crimped your pretty curls.

Here in this town, not many days agone,
A pretty minion, faultlessly attired,
Whose paint, whose starch left naught to be desired,
For greater grace put matrimony on.
Come to the vicar, then, the spirited saint
Says to the couple: You have so much paint,
You have such equal wealth of furbelows,
Your curls lie blond in such identic rows,
I count on your assistance to decide
Which lady is the man and which the bride.

NOTE 4.

I ask the indulgence of my readers. I offer them only some observations and some recommendations. This would be impertinent on my part if uranism did not call for a new investigation and (aside from some brilliant exceptions) a broader and more intelligent point of view. I hope, if the preceding pages have had the good fortune of interesting any readers, to develop the ideas which I have outlined.

TRANSLATOR'S NOTE.—The American reader will notice that the social conditions upon which this paper is based are those of Europe and differ widely from those of this country. The more strict stratification of society, the greater density of population, the requirements of military service and many other causes may operate in the European countries to foster forms of vice with which we with our more sparse population and different social organization may be as yet little familiar, at least so far as concerns our native-born population. To the present writer it would seem that the dangers to be guarded against in this country at present centre not so much about the preventitive education of possible uranistic children as about the prevention of those social conditions which encourage the spread of these and similar vices. With the massing of our population, especially the foreign element, in great cities, these dangers will assume greater and greater importance.

The translator desires to express his grateful acknowledgement of valuable assistance rendered by Professor G. F. McKibben in revising the translation.

C. JUDSON HERRICK.

THE HISTOGENESIS OF THE CEREBELLUM.

By C. L. Herrick.

We are impelled by a recent paper from Dr. Schaper to review the utterances of this journal respecting the cerebellum. In the article referred to[1] several of these publications are referred to but are dismissed with the remark, which is made to apply to all previous work, "Ihre Resultate jedoch erheben sich kaum über Vermuthungen." Welcoming as we do the circumstantial confimation of our own investigation we can but feel that the positive results we had published and which rested on long and often-verified study merit a recognition they have not received from Schaper or other subsequent writers. Reviewing Schaper's work we find nothing new respecting the morphology of the organ until we reach the statement that the origin of its substance is not a thickening of the dorsal wall but the migration of elements from two lateral analags. But His has already shown that the cerebellum arises from the Flügel-platten or lateral aspects, and the writer in 1891 gave a detailed account of the process in the rodents and has repeatedly verified the process in other mammals and lower groups. Plate I of Vol. I of this journal illustrates the morphological relations so fully that it has never seemed necessary to amplify the description. Pages 11-13 of this same volume give a description of the way in which the dorson of the cerebellum (which is originally devoid of cells) receives contributions from the everted walls of the lateral recesses and the caudal margin. Of course it is not understood that such folds are mechanically produced but that the sequences of proliferation follow so as to accomplish a result which can only be thus imaged. Em-

[1]A. Schaper. Die Morphologische und histologische Entwicklung des Kleinhirns der Teleostier. 1894.

bryological literature is full of such usages and no confusion was anticipated therefrom, though it has resulted in the case of some reviewers untrained in embryology. On p. 669 of Schaper's paper we read that "in der Deckplatte der Medianfurche und in den Begrenzungsgebieten der beiden Ressus laterales wir drei Orte vor uns haben, von denen nunmehr das neue Material zur weiteren Entwicklung das Kleinhirns bezogen wird." These statements are anticipated in the first number of this Journal and fully illustrated. Schaper then proceeds to discuss the superficial cell layer of the cerebellum which, he says, "findet sich, so veil wir wissen, nur im Kleinhirn." He indeed says "I believe that my observations derived from faultless preparations warrant me in supporting Herrick's theory and to extend it by adding that, in fishes at least, the '*Deckplatte der Medianfurche*' participates in this process, a fact which seems to acquire special significance from considerations to be mentioned later." The descriptions and figures given in the article referred to and subsequently will show that this locus was especially recognized by us as a source of proliferation. Thus on p. 13, "While in this case [black snake] the organ does not undergo reflection but remains a leaf-like organ, longitudinal sections indicate that proliferation is most rapid near the tip, and a dense clustre of cells is pushed dorsad and cephalad upon the dorsal surface." Respecting the source of the elements the same passage continues "There is every reason to conclude from these sections that the cells of Purkinje likewise spring from near the ventricular border. At the tip and lateral margins, the layer of these in the embryo comes in contact with the epithelium, and the cells which are obviously multiplying rapidly, either spring from the epithelium by subdivision of its undifferentiated cells or the multiplication of special germination cells. The neuroblasts at first become spindle-shaped and give rise to a process which passes cephalad. Nearer the base the layer of Purkinje cells is represented by a thick nucleary zone from the epithelium. At the very base, however, there is a superficial dorsal cell-aggregate which likewise seems to have its origin in the epithelium of the ventricle." On the ninth page

the origin of the superficial layer is described. "This remarkable assemblage of superficial cells with dividing nuclei, karyokinetic figures and other evidences of proliferation may be readily seen in the cerebellum of old embryos of the guinea-pig. . . . We observe that in an older embryo a much larger portion of the dorsal surface has been thus covered, and evidently from behind forward. A transverse section of the cerebellum near its base in a mouse embryo of a little older stage, shows that the entire surface has now been covered by the proliferating zone, but that it is curiously double, with a layer of white fibres separating the two zones. It is also observed that the walls of the nerve tube at the recessus lateralis of the fourth ventricle are very thin, and consist of rapidly proliferating and hence closely-packed cells which pass from the ental to the ectal surface. This section suggests that possibly the lateral and caudal portions of the ventricular surface of the cerebellum may be the sources of the proliferating superficial layer of the dorson." The form of this statement may have led Schaper to speak of our statements as "Vermuthungen" but the article goes on to afford proof that this "suggestion is valid" by a study of the origin of the recessus lateralis. On p. 12 we have "From either side there extends a curious upward fold containing a cavity. The source of the growth is evidently the walls of the cavity as witness the numerous cells clustred at that point." "It will be noticed also that the entire dorsal portion of the organ is affected by this overlapping growth from behind and the sides, so that a groove is formed on either side of the meson, dorsally." "Fig. 7 well exhibits the extent to which the gray matter of the dorso-lateral aspect of the medulla is derived from the epithelium of the recessus lateralis." One word also respecting the idea that the cerebellum is peculiar in the possession of a transitory superficial proliferating zone. Fig. 4 of Plate II of Vol. I of this Journal was drawn to call attention to the development of a proliferating zone in the cerebrum. Though this zone is not strictly superficial it nevertheless corresponds to the layer in question and is a centre of mi-

gration. Similar stages have been observed in other parts of the brain, as in the optic lobes.

A more detailed account of the fate of the superficial layer is given in the supplement to Wood's Reference Handbook of the Medical Sciences. From the article on Histogenesis of the Nervous System, (p. 692) we quote the following paragraph: "The ectal portions of the massive organs, especially the cerebrum and cerebellum, become somewhat rapidly clothed with a dense mass of granules which subsequently disappear (Fig. 496). Professor His suggests that these are white blood-corpucles which, after wandering from the sinuses surrounding the organ, make a temporary halt near the surface before passing throughout the substance of both gray and white matter. The period at which they appear in the human embryo is about the end of the second month. While not doubting the existence of amœboid cells, as above described, the writer has suggested other sources for part of these cells. It will be noted that the peripheral zone of cells arises only after direct communication with the ventricles has been cut off by interpolated white matter. Subsequently the number of granules (*e. g.*, beneath the Purkinje layer in the cerebellum) rapidly increases. Their source can only be the peripheral collection of granules. Fig. 496 shows that, at this stage, there is often rapid multiplication going on within that layer. Careful study has not revealed any other source for these proliferating granules than diverticles of the epithelium, from which migration in this more round-about way is kept up. It is a familiar fact that the earlier granules are derived from the proliferating neuroblasts of the ventricular surface: it is inherently improbable that the subsequent ones should spring from as distinct a source as the pia or its vessels. The peripheral proliferating layer soon disappears by the migration of its elements toward the ventricle."

One statement made by Schaper (p. 693) is in our belief inapplicable to fishes or at least is not universal. He says, "Das ursprüngliche 'embryonale stützgerüst' geht bis auf die zu eigentlichen ependymzellen sich wandelnden elemente mit aller warscheinlichkeit früzeitig zu Grunde." We have shown that

in fishes and reptiles the original spongioblastic skeleton persists and may be easily made out in properly prepared sections of the optic tectum and other regions extending from ectal to ental surfaces. Moreover the much-mooted "gelatinous tracts" are frequently but the elongated fibre-like connections between the two free surfaces which have been separated by the distortions due to growth. Compare Plate XXVIII, Figs. 1 and 7 in Festschrift f. Leuckart, and discussion on p. 45-46 of this Journal for May, 1892. In an article in the *Denison Quarterly*, republished in this journal for Dec., 1892, pp. 141-142, the origin of the cerebellar elements from proliferations of epithelial origin is again described. On p. 86 of the June number for 1893, is a discussion of the primary or transitory layer in the cerebrum. See also Anatomischer Anzeiger, VII, 13, 14. Dr. Schaper deserves great praise for his thorough study of the subject and it in no way detracts from the merit of his work to call attention to the fact that he does not stand alone in his positions.

THE MAMMALIAN CEREBELLUM.

By Bert Brenette Stroud, B.S.

Part I. The development of the Cerebellum in Man and the Cat.[1]

Introduction.

In 1891 the writer prepared a baccalaureate thesis on the Flocculus. The present investigation was begun as an effort to determine (1) whether the flocculus occurs in all mammals and (2) what are its anatomy, histology and functions. It soon appeared, however, that these questions are part of a more comprehensive problem as to the constitution of the entire cerebellum.

Acknowledgements.—This thesis has been prepared in the Anatomical Laboratory of Cornell University. It is with the greatest pleasure that I acknowledge my indebtedness to Professor B. G. Wilder for permission to examine all of his preparations and for criticism, counsel and encouragement.

I am indebted also to Professor S. H. Gage and Instructor P. A. Fish for advice as to methods, photographing specimens, etc. ; to Mrs. S. H. Gage for suggestions as to drawings and for permission to examine sections of embryo kittens' brains ; and to Dr. H. B. Besemer and other medical friends for valuable material.

[1]Part I was presented to the Faculty of Cornell University as a thesis for the degree of Doctor of Science, May 1, 1895. The remaining parts (Comparative Anatomy, Histology and Function) will be published as soon as circumstances permit.

LIST OF BRAINS EXAMINED.

NOTE.—The following list, while incomplete, will indicate approximately the nature of the material upon which the writer has based his conclusions.

The accession numbers are the serial numbers on the Accession Book of the Museum of Vertebrate Zoology of Cornell University.

It is unnecessary to more than mention the brains of the cat, dog, and sheep; the laboratory is well supplied with them.

Embryo brains of man and the cat are enumerated in the descriptions of plates. A list of the adult human material studied will be given in Part II.

Ac'n No.	*Sex.*	*Age.*	*Groups.*
			SUB-CLASS I. PROTOTHERIA.
			ORDER I. MONOTREMATA.
66	Male		*Echidna aculeata*, spiny anteater.
76	Male		*Ornithorhynchus anatinus*, duck-bill.
			SUB-CLASS II. METATHERIA.
			ORDER II. MARSUPIALIA.
3559	Female		*Didelphys virginiana*, common opossum.
712	Female		" " " "
67	Male	Fœtal	" " " "
			Twelve or fifteen specimens were available.
1331	Male		*Macropus giganteus*, giant kangaroo.
378			" " " "
108	Male		*Hypsiprymnus moschatus*, kangaroo-rat.
			SUB-CLASS III. EUTHERIA.
			ORDER III. EDENTATA.
126		Adult	*Bradypus tridactylus*, three-toed sloth.
3220	Male	Adult	*Tatusia septemcincta*, seven-banded armadillo.
			ORDER IV. SIRENIA.
844	Male	Adult	*Manatus americanus*, American manatee.
			ORDER V. CETACEA.
670	Female		*Globiocephalus melas*, black-fish, pilot whale.
			ORDER V. UNGULATA.
2177	Male		*Camelus bactrianus*, Bactrian camel.
692		Fœtus	" " " "
2122	Male	at term.	*Camelus dromedarius*, dromedary.
961	Male		*Cervulus elaphus*, red deer.
1207		Juv.	" " " fawn.
776			*Cariacus dama*, fallow deer.
2679			*Ovis aries*, common sheep.
195		Fœtus	" " " "

Ac'n No.	Sex.	Age.	Groups.
2125	Male		*Equus caballus*, domestic horse.
2126	Male		" " " "
2262			" " " "
3078	Male		" " " "
2776			" " " "
3371		Fœtus	" " " "
2259			*Equus asinus*, burro.
2127			
372			*Sus scrofa*, domestic pig.
2763			
3365		Fœtus	" " " "
2123			*Tapirus malayanus*, Malayan tapir.
3362	Female	Adult	*Bos taurus*, domestic cow.
3364			
2657			" " " "
2729			
			ORDER VII. TOXODONTIA.
			No specimens.
			ORDER VIII. HYRACOIDEA.
			No specimens.
			ORDER IX. RODENTIA.
411	Female		
487	Male		*Arctomys monax*, woodchuck, marmot.
3075	Female	Adult	*Castor fiber*, American beaver.
269			*Cynomys ludovicianus*, prairie dog.
2906			
3212			*Fiber zibethicus*, muskrat.
2938	Female		
3370	Male		
3352			
3353			*Lepus cuniculus*, rabbit.
2907			
2960			
3357		Adult	*Mus decumanus*, brown rat.
			Mus musculus, domestic mouse.
3367	Male		*Sciurus hudsonius*, red squirrel.
737	Female		
3121			*Sciuropterus volucella*, flying squirrel.
			ORDER X. PROBOSCIDIA.
2181	Female		*Elephas indicus*, Indian elephant.
			ORDER XI. CARNIVORA.
144	Male		*Canis aureus*, Indian jackal.
3369	Female		" *dingo*, dingo.
2124	Male		" *latrans*, coyote, prairie wolf.
2937	Male		" *familiaris*, domestic dog.
1803	Male		" " Scotch shepherd.
175	Male		
2919	Male		" " St. Bernard.
163	Male		" " Blood hound,
			and several other varieties.
146	Female	8mo.	
151	Male	48hr.	*Felis leo*, African lion.
157	Female	22da.	

Ac'n No.	Sex.	Age.	Groups.
195		11 wk.	*Felis leopardus*, leopard.
156	Male		*Felis concolor*, puma.
309	Female		
2945	Male		" (*borealis*) *canadensis*, Canada lynx.
277	Male		" (*borealis*) *rufus*, common lynx.
304	Male		" (*borealis*) *maculata*, Texas lynx.
783	Female	Juv.	*Felis pardalis*, ocelot.
263			*Felis domestica*, domestic cat.
399	Female		
452	Male		
752	Female		
308	Female		*Hyaena striata*, hyena.
3156		Juv.	*Vulpes fulvus*, red fox.
770	Male		
158	Male		
3199	Male	Juv.	
2946	Female		
3131	Female	Adult	*Lutra canadensis*, otter.
2779	Male		*Procyon lotor*, raccoon.
2031	Male		
2822			*Mephitis mephitica*, skunk.
3361			
143	Female		*Nasua rufa*, coaiti-mondi.
3155	Female	8 da	*Putorius vison*, mink.
3156	Female	8 da	
3157	Female	8 da	
3089	Male		
194			
196	Female		*Putorius domestica*, ferret.
197	Male		
3368		Adult	" *vulgaris*, weasel.
170	Male		*Phoca vitulina*, seal.
171	Male		
152	Female	1-2 yrs	*Ursus americanus*, black bear.
645	Male		" *torquatus*, Thibet bear.
			ORDER XII. INSECTIVORA.
517	Female		*Blarina brevicauda*, mole shrew.
3356			*Condylura cristata*, star-nose mole.
3093			*Galeopithecus volans*, colugo.
			ORDER XIII. CHEIROPTERA.
349			*Alatapha noveboracensis*, red bat.
3164		Juv.	" " "
2359			*Vespertilio subulatus*, common brown bat.
			ORDER XIV. PRIMATES.
			A. Lemuroidea.
22			*Nycticebus tardigradus*, loris.
3205			*Tarsius spectrum*, tarsius.
571			*Chiromys madagascarensis*, aye-aye.
			B. Anthropoidea.
			Marmosets.
664	Male		*Hapale jacchus*.
342	Male		*Midas œdipus*.
2918	Male		
3111	Female		—— —— Marmoset.

Ac'n No.	*Sex.*	*Age.*	*Groups.*
			Cebidæ.
2911	Female		*Cebus apella.*
1808			*Ateles melanocheir.*
3375			
3104	Female		*Callithrix sciurieus.*
			Cercopithicidæ.
307	Male		*Cynocephalus anubis*, baboon.
308	Male		
2977	Female		*Cynocephalus babuin*, common baboon.
3327	Female		
3215	Female		
2555	Female		*Cynocephalus sphynx.*
3073	Female		*Macacus cynomologus*, common macaque.
3219			
2872	Male		" *erythraeus.*
3072	Male		*Macacus nemistrinus.*
2998	Male		
3171	Female		*Macacus rhesus*
3068	Female		
3076			
2988	Male		
2888	Male		
3196	Male		
2873	Female		
2548		Juv.	*Simia satyrus*, orang.
3082	Female		
265	Female	Juv.	*Anthropopithecus troglodytes*, chimpanzee.

A. Macroscopic methods.

Having obtained an embryo, the first thing to do is to harden it. If the specimen is quite small simply immerse it in 50 per cent. alcohol, one to three days; in 67 per cent. alcohol, one to three days; finally in from 75 per cent. to 80 per cent. alcohol, where it may remain indefinitely. The brain may be exposed at leisure.

Dissection of Fresh Specimens.—With older embryos where the cartilaginous skull is thick or has begun to ossify, the brain must be exposed at once or it will not harden well. This is a delicate and tedious operation for the young tissues are so soft that when an opening has been made through the skull, a slight pressure upon almost any part of the head will force a considerable portion of the brain out through the opening, which of course ruins the specimen.

The method employed by the writer has been to wrap some absorbent cotton around the body of the embryo and

then place it in a cradle made from a piece of sheet lead bent in this way . The sides are bent together just enough to hold the specimen in place.

The whole is then immersed in a solution of common salt, glycerine and water, or any other suitable liquid of a specific gravity such as will float the embryo. Then with fine forceps, scissors, and needles piece by piece, the skin and skull are removed. The pia should be removed after it has been in the 75 per cent. alcohol for a day or two.

The hardening fluid must not contain glycerine, for it shrinks the tissue; chromium salts make the brains too brittle. The writer prefers plain alcohol for hardening specimens to be used for gross preparations.

Mounting for Museum Specimens.—A convenient support for small embryos is made from strips of basswood cut into suitable pieces. These are first boiled in water to which has been added a little caustic potash solution, and then in water containing a small amount of hydrochloric acid to remove all extractive and coloring matter. The blocks are further washed in water, dried, smoothed, coated with glue and finally painted with carbon drawing ink[1] and dried.

The blocks are weighted with lead. The specimen may be attached by means of small pins, preferably made of silver, or aluminum.

Figuring.—The writer found great difficulty in obtaining correct outlines of embryonic brains. At first an attempt to photograph them was made. This method, while giving excellent results for large specimens, proved unsatisfactory for small ones. Outlines were made with the camera lucida and details added free hand, the specimen being kept in a vessel of alcohol all the time, whether it was to be photographed (Gage, 12) or drawn with the camera lucida. The object should be well lighted.

---

[1]The use of basswood and carbon ink was suggested by Professor S. H. Gage.

B. Microscopic methods.

1. Morphology.—Where the specimen is too small to be readily handled, it can be examined much more easily if sectioned than in any other way. However one should have both a gross preparation and sections of the same stage of development whenever possible. A perfect idea can be obtained in no other way. Sections also should be cut in three different planes: (*a*) Sagittal sections; (*b*) Transections; (*c*) Frontal sections.

It may not be possible to obtain four specimens of the same stage, but transections and sagittal sections are almost indispensable. Where only one specimen is available, the writer has adopted the following method. First, cut sagittal sections till the meson is just passed, then remove the tissue from the block and fix it on again so as to cut the remainder of the tissue in transections. Figure 32, Pl. III is drawn from a section which illustrates this procedure.

The fixing, hardening, imbedding, etc., should be the same, whether one wishes the sections for morphology or histology. If for the former, sections may be cut much thicker, from 40 microns to 120 microns, and should be stained only very lightly, the thickness of sections and amount of tissue cut noted so that one can make a wax model, if desired. Sections are cleared and mounted in balsam in the usual manner.

2. Histology proper.—Tissue may be fixed and hardened after any of the approved methods. The writer has used alcohol and potassium dichromate; also 50 per cent. alcohol saturated with common salt two to four days, then alcohols as in *A*, with good results. Before fixing, the skull must be removed; but great care is needed to avoid tearing the delicate telas and other membranes.

Imbedding.—This must be very carefully and thoroughly done, or loss will be the inevitable result. After dehydrating, the tissue is placed in a mixture of equal parts of strong ether and 95 per cent, alcohol for two days; then into 2 per cent. collodion for 2 to 3 days; then into 6 per cent collodion for 4 to 10

days. This last infiltration with thick collodion is exceedingly important, for upon its thoroughness the usefulness of the specimen depends. It is well to allow the collodion to become quite thick before the final imbedding. When the process has been carefully done it is an easy matter to cut even large sections 10 microns thick.

Tissue is imbedded by placing it in a small paper box and filling the box with thick collodion; the box is then placed in a jar of chloroform which hardens the collodion. The object is cleared and cut in the castor-thyme oil mixture: red oil of thyme, 3 parts; castor oil, 1 part.[1]

Staining sections.—Nearly all of the usual staining fluids gave good results. Of the hematoxylin stains Gage's, Herrick's, and Mallory's hematoxylin proved highly satisfactory.

Forms selected.—Two forms have been chosen to illustrate the development of the mammalian cerebellum.

1. The Cat, a fairly representative mammal, from which embryos of different ages may easily be obtained.

2. Man whose brain is very highly specialized. An attempt has been made to determine in what the essential differences and agreements consist.

The cat was studied first, because its brain is less modified than that of man.

Plates.—All the figures have been carefully drawn from nature by the writer from his own dissections. Of the gross preparations each one has been minutely examined by aid of a lens and drawn at least twice; indeed some have been drawn several times. Detailed explanations will be given in the description of plates.

Those relating to the cat, Plates I and II, were studied first and all except Figs. 1, 2, 3, and were 23 drawn from careful measurements. Figs. 1, 2, 3, were outlined by the camera lucida and 23 was photographed.

Plate III shows sections of embryo kittens' cerebellums.

---

[1]P. A. Fish. A new clearer for collodionized objects. *Proceedings of the American Microscopical Society*, XV, pp. 86-89, 1893.

Plate IV shows sections of both kitten and human cerebellums. Plates V to VIII show gross preparations of embryonic human cerebellums.

In the figures no attempt has been made to show parts other than those concerned in the subject of this paper; but to facilitate orientation the oblongata, the mesencephal, and in a few cases the cerebrum have been added in outline.

Defects.—Material and time to trace every consecutive step in the development of the cerebellum are lacking; but it is believed that the most important stages have been studied and discussed. The conclusions given are to be regarded as the writer's interpretation of his available material and subject to such modifications as further research may require.

Terminology.

A careful study of the cerebellum in the different groups of mammals will convince even the most sceptical that the descriptions found in the present standard works on encephalic anatomy are inadequate for an exact comprehension of this important organ; *i. e.*, the mammalian cerebellum does not fit the description.

If we take a cerebellum from each of the fourteen orders of mammals, beginning with the monotremes and ending with the primates, at first sight one would say that they are as unlike as are cats from horses. But closer inspection shows that they all agree in certain fundamental characters.

On the other hand it may be said that a given region which is very prominent in the cerebellums of animals belonging to one order may in another order be so reduced and overshadowed by adjacent parts as to be altogether overlooked.

It may not be clear at first but my investigations have convinced me that there is *one* fundamental plan for the cerebellum running throughout all mammalia, but that this plan is variously elaborated in the different orders.

Therefore the writer ventures to suggest that our present conception of the cerebellum is incomplete.

Perhaps the greatest cause for this misconception lies in the

fact that at first it was not thought worth while to study other than human brains. So the human condition was taken for the standard ; and when the brains of the lower mammals came to be studied they were warped into an agreement with the assumed standard condition found in man.

Now this is a serious error. For the human cerebellum represents a highly specialized form. It is, in fact, a morphological monstrosity and can in no sense be taken for the typical mammalian organ. The writer also believes that certain of the morphologically distinct regions have not been recognized, that parts of the same morphological integer have not been considered as such, and that we have as yet no exact standard for comparison.

The writer's idea is that the typical mammalian cerebellum would be a *composite* drawn from careful comparisons of the cerebellums of all the different orders. Because,—

1. The fundamental plan appears to be the same for all.
2. A given region or feature may be excessively developed in one order and almost obliterated in another order.

Having thus briefly indicated a few reasons why, in the writer's opinion, the present terminology of the cerebellum should be modified, it is only proper to state the opinions of some of the authorities on encephalic anatomy.

More than twenty yeas ago Professor Wilder (34) remarked:

"But the part most enveloped in obscurity, as to its development, its structure, its functions, its size, nay, its very existence, is the cerebellum."

"The development of the brain is treated only as a division of embryology and as such is apt to be overlooked until after the time when it might be most useful in aiding the comprehension of the organ."—Idem (35, 142).

"Usually the adult human brain is the first and only object of examination and is taken as the standard of comparison ; if animal brains are studied at all they are often taken as they come, or as anatomical rarities, not selected in accordance with a principle which might indicate the probable degree of their usefulness. The comprehension of the macroscopic morphology of

the brain involves the removal of difficulties varying in kind and degree. These several categories of difficulties should be attacked separately and in the order of (1) their fundamental importance and (2) their simplicity."—Idem (55, 145).

A. Van Gehuchten says (32, p. 32): "Les sillons les plus profonds des deux faces du cervelet, ainsi qui les lobules qu' ils délimitent, ontrecu des noms particuliers. Mais nos connaissances de la structure et surtout des fonctions du cervelet sont encore si incomplétes que, dans l'état actuel de la science, cette division et cette nomenclature n'ont guére d'importance."

Alfred Schaper (28, p. 493) thinks, from his investigations of the brains of teleosts, that present statements concerning the development of the cerebellum are incorrect and that further investigations should be made.

"In descriptive anatomy an astounding variety of names are applied to the various parts of each lobe of the cerebellum; it would be an essential gain if at least three fourths of these names could be discarded."—Charles Sedgwick Minot (23, 674).

To this the writer would add that, whatever the structure of the cerebellum may be, its terminology must be such that an accurate description of it can be written.

And further, that numerous instances, in standard literature, can be cited where descriptions and figures of brains are incorrect or incomplete, due in some cases, as remarked by B. G. Wilder (35) to,—

1. "Injuries in removal,—by which the appendicular lobes, hypophysis, olfactory bulbs, have been torn off and left in the skull, telas and other delicate parts of the brain have been ruptured" so as to convey the impression of openings which did not exist in nature.

2. Failure of the artist to comprehend morphological details. Anatomical drawings to be useful, ought always to be made from carefully prepared specimens, by some one who has at least a good working knowledge of the general anatomy of the parts concerned.

"It (the cerebellum) must be considered as a compages having throughout, from centre to innermost recess, connection

and contiguity, forming such a wicker tissue as to present a labyrinthine and, to the anatomist, completely inexplicable knot, unless nature while living in this intricate abode teaches him to unravel her tissue in the same order in which she herself composed it."—Emanuel Swedenborg, 1744.

"Search after the fundamental lines in the structures of the brain is the present task of the brain anatomist. Once we have accomplished this, it will be easy to understand the complicated conditions present in the more highly organized brain." —Edinger (9, vi).

"The key for understanding the complex brain must be sought in the study of its earliest embryonic stages."—Wilhelm His (16, 348).

The examination of the adult cerebellum gives absolutely no conception of what the organ was like in its earlier development. The only way that it can be comprehended is to "see it grow."

The ectal appearance of the adult organ is that of an oval corrugated mass. The caudal aspect presents an appearance like that of a little hill in a valley between two high mountains. The cephalic aspect is more like that of a long hill in the middle of a plain. The entire surface, plain, hills and mountains, is cut by a perplexing tangle of little ravines and deeper gorges, for the most part parallel, whose beginnings and endings are as bewildering as are the figures of the quadrille to the novice.

A closer inspection shows that there are lobes separated by deep fissures, and that the lobes in turn are cut into a greater or less number of narrow folia by shallower fissures. These lobes have received special names, many of which are artificial and unscientific.

But the study of the adult organ can give no better knowledge than this.

If, however, we begin with early embryos and trace the development of the cerebellum to its adult condition, many of the difficulties disappear.

The writer believes this method to be the soundest one

and that it should always be followed if we expect to gain an intelligent knowledge of the brain as a whole or in part.

So far as we can judge from the study of two forms so widely separated as are man and the cat, it seems probable that the general structural plan is the same for all mammals. The question then arises, what is the difference between man's cerebellum and that of other mammals?

If one had specimens from the whole mammalian series placed before him, it is true the first impression would be that there was little resemblance between them, least of all to man's. A closer study and analysis discloses many features which do appear to be homologous. And I can positively say that so far as the embryos of cat and man are concerned the early stages are apparently identical. The same features and regions are present Both start from the same point; soon, however, modifications appear and the two rapidly diverge from each other. But in spite of all this, embryonic regions, whether they become almost obliterated or hypertrophied beyond all proportion, do persist throughout the life of the individual.

But to return to the question, how does man's cerebellum differ from the others? I hold that it is simply a case of *difference in degree of development.*

Intrinsic Terminology.—Unfortunately we possess no intrinsic terminology of the cerebellum. What effort has already been made in that direction is mostly of a superficial and artificial character. The thing needed is a terminology which shall apply equally well to the cerebellum of an opossum, a sheep, or man. Until this has been done, the cerebellums of different mammals can not be easily compared.

The introduction of new terms, while undesirable, is a necessity, because the present terminology is inadequate. There are distinct regions which, it is believed, have never before been recognized. Wherever new terms occur they will be explained. In all possible cases terms already familiar have been retained.

It seems to me that terms applied to parts of the cerebellum ought not to be applied to structures of the cerebrum;

e. g., the term *peduncle*, applied to the peduncles of the cerebellum, has also been used in another sense to indicate bundles or tracts of fibers in both the cerebellum and the cerebrum, which latter use can not come under the original meaning of the term. Confusion would be avoided if those structures were designated by terms which should mean what they are, bundles or tracts of fibers. The needs of a progressive and scientific comparative neurology demand terms which are appropriate and not likely to be confounded.

Principles of a Terminology.—

1. Terms should mean something.
2. They should be appropriate.
3. They should be euphonious.
4. They should be mononyms ; *i. e.*, single word terms.
5. They should, when possible, indicate a definite idea of the morphologic or embryologic form or relation of the structures designated.
6. The same term should not be used to designate two different things either in the same brain segment or in different segments.

Morphologically the foldings in the cerebellum are probably homologous with those in the cerebrum and the same statement is true for the fissures. But it does not seem advisable to employ the same term for those structures in two different brain segments. Therefore we shall designate a fissure of the cerebellum by the term *sulcus*, as proposed by Wilder, and an adjoining ridge by the term *folium*. (137, p. 125.)

Inconsistencies in old terms.—Peduncles.—For the purpose of general and comparative morphology the writer would suggest that it would be best to restrict the term *peduncle* to the peduncles of the cerebellum, and to regard each peduncle as containing at least three great fiber tracts : viz., (1) the cephalic tract, (2) the ventral, or pontile tract, (3) the caudal tract. These are called by Wilder respectively *prepeduncle*, *medipeduncle*, and *postpeduncle*.

Vermis.—The term is both inappropriate, and ambiguous.

But it has taken so firm a root in the literature, that it might be unwise to discard it. It simply designates the mesal part of the cerebellum and is a secondary development.

The vermis as it exists in the adult brain is not present in early embryos.[1] See also Plate I, Figs. 8 and 10, Plate V, Fig. 56, Plate VI, Fig. 58.

The writer fails to recognize it in his specimens till the other parts are quite far advanced in development. Compare Figs. 17, 20, 69, and 72. Considering the mode of development, the term *fastigium* would be more appropriate than vermis.

Hemispheres, Lateral lobes.—The cerebellum is commonly described as consisting of three parts, a middle part, vermis, and two lateral parts, the so-called lateral lobes, or hemispheres. This, it is true, is the apparent condition in man, but we shall show later that it is not the real condition, for the parts which seem to be lateral are so because their excessive development has overshadowed and concealed parts which lie still farther laterad. This is clearly seen in the lower mammals.

The mammalian cerebellum presents at least four distinct regions; viz., one mesal and three lateral regions.

1. The middle part (vermis).
2. The pileum (hemisphere or lateral lobe).
3. Paraflocculus (accessory flocculus).
4. Flocculus.

These regions will be discussed farther on.

Historical.

During the first quarter of this century an interest began to be manifested in the development of the cerebellum. The writings of one French and three German investigators upon this subject are recorded.

The first work that I have found mentioned was in 1812, by Ios. et Car. Wenzel (33, 256). It is quoted by Burdach (3,

---

[1]This was mentioned by Wilder (37, p. 125.)

419), who states that in a child three years old the ratio of the cerebellum to the cerebrum was 1 : 6.

In 1814 Ignaz Döllinger (8, 19) stated that at the middle of fetal life the cerebellum is proportionally the smallest, being to the cerebrum as 1 : 24, but that it rapidly increases till at one month after birth the ratio is 1 : 17, and in the adult it is 1 : 6.

In 1815 Serres (29, 77-107) stated that in the human embryo the cerebellum does not appear until the seventh week of development, and in the fowl until the sixth day of incubation. He also says that the organ is formed in the following manner: two laminæ spring from the crura of the cerebellum (Kleinhirnschenkeln) and come to rest against each other at the meson. Later they gradually grow together, after which new lamellae are added both cephalad and caudad, and transverse furrows appear and multiply.

In 1816 Tiedemann (31, 155) says, "At the beginning of the second month a soft fluid substance occupies the place of the cerebellum. Later in the month two small thin plates arise from each side of the oblongata, along the fourth ventricle, turn inward and rest against each other, but do not unite till later. In the third month they have increased in size and represent the *corpora restiformia*, called peduncles by Willis and crura by other anatomists."

There follows a period of about forty-one years during which no attention appears to have been given to the subject.

The next reference that I find is a work on the development of the brain by Krishaber (19), published in 1865; the next to a description of a fetal brain by Callender (5), in 1870.

1874. His (14, 106) says, "The cerebellum, in most orders of mammals is divided into a middle part (vermis) and two lateral pieces separated from it by a furrow. The vermis is formed from the mesal roof of the brain tube, *i. e.*, out of such constituents as were present before the development of the lateral masses (hemispheres)."

1876. Mihalkovics (22, 53) says, "The roof of the epencephal (Hinterhirndecke) forms an expanded lamella which

arches over the epicœle. At the right and left it bends over into the epcœlian floor. Cephalad it is separated from the mesocœlian roof by a constriction, and becoming thinner caudad, merges into the metatela. From the caudal aspect, because of the wedge-like cephalic point of the metatela, this lamina looks like a pair of lateral plates. This plate may be called Kleinhirnlamella, (lamina cerebelli) because it is the proton (Anlage) of the future cerebellum. The cerebellum is formed from this lamella in the following manner: the cephalic portion of this lamella thickens, while the caudal edge at the transition into the metatela becomes sharpened."

This thin margin bends ventrad and there results a plait-like folding in along the caudal edge of the 'Kleinhirnlamella.' The cephalic, thickened part of this *transverse* plait (or fold) is the proper proton (Anlage) of the cerebellum. The caudal is the "hinteres Marksegel,' (velum medullare posticum, v. Tarini)" or what the writer calls kilos. From his own observations the writer can not accept this view as to the development of the cerebellum.

1877. Alix (1) published a paper on the fetal brain.

1878. Kölliker (20, 537) says, "The cerebellum is developed as a thickening of the cephalic part of the roof of the epencephal (Hinterhirn), which soon assumes the form of a transverse plate. From the lateral aspect it looks as though it bent around the epencephal (Hinterhirn)."

1884. Wilder (35, 179; 37, 125) figures the cerebellum of a human embryo in which the lateral parts are massive, the mesal region is thin and presents a wide groove upon the dorsal surface. It is probably a little older than the embryos shown in Figs. 54 and 56, Pl. V.

1890. Hertwig (18, 360) says, "The wall of the fourth brain vesicle undergoes a considerable thickening in all of its parts, and surrounds its cavity in the form of a ring, differentiated into several regions. The floor furnishes the pons. From the lateral walls arise the *pedunculi cerebelli ad pontem. But it is the roof that grows to an extraordinary extent and gives to the cerebellum its characteristic stamp.* At first it appears as a thin

transverse ridge which overhangs the thin attenuated roof of the medulla."

1891. Herrick (13, 5-14) describes his investigations upon the brains of rodents and certain reptiles. He obtains results which throw a new light upon the cerebellum and mark an epoch in the study of its histogenesis. He has discovered proliferating regions in the epicœlian roof which apparently are identical with the writer's lateral protons.

Professor Herrick makes a strong plea for the application of the comparative method to the study of neurologic problems. To this argument, the writer joins his most hearty support.

1891. His (15) discusses the development in the human brain of the region from the isthmus to the myel, during the period from the end of the first to the beginning of the third month. He includes the entire region under one segment, the Rautenhirn, but does not deal especially with the cerebellum.

1892. His (16, 373-375) gives a brief description of the development of the cerebellum. He says, "The embryonic epencephal (Hinterhirn) appears as a conical tube of which a portion of the metatela (Rautenfeld) forms a part. Its caudal limit is at the pons flexure; its cephalic, if we first subtract the constituents of the isthmus, is at the isthmus flexure. Between the pons flexure and the isthmus flexure lies the dorsally convex knee of the epencephal. The metatela narrows rapidly caudad from the knee, but a narrow extension of it whose edges are nearly parallel extends cephalad. The floor of the metepicœle (fourth ventricle) is formed from the ventral zone (Grundplatte), the cerebellum from the dorsal zone (Flügelplatte). Its hemispheres are formed in the higher vertebrates from the part of the dorsal zone lying caudad of the knee, the vermis from the part lying cephalad of it."

1893. Schäfer (27, Vol. I, Part I, 66) says, "The roof of the fourth ventricle inferiorly becomes greatly thinned and expanded. Superiorly the tube becomes gradually more contracted and the roof thicker. This thickening being the rudiment of the *cerebellum* and of the *valve of Vieussens*. In the

human embryo, the cerebellum is seen as early as the second month as a thin plate arching over the cephalic part of the metepicœle (fourth ventricle). From this plate, which enlarges only gradually, is formed the middle lobe; later the lateral lobes grow out at the sides."

"The cerebellum consists of two lateral *hemispheres* joined together by a median portion called, from its peculiar appearance caused by the transverse furrows or ridges upon it, the worm or vermiform process, ... in mammals it is the first part to be developed and to be marked off into subdivisions." (Idem., Vol. III, Part I, p, 69.) I shall show that the vermis is not the first part to be developed and marked off into subdivisions.

1894. Schaper (28, 489) published an account of his exhaustive investigations upon the development of the cerebellum in Teleosts. He confirmed Herrick's discoveries and made further observations of great value. His work, and also that of Professor Herrick, will remain as landmarks in the history of the comparative development of the cerebellum.

Having thus given a brief *resumé* of the opinions of the men who have made a special study of the development of the cerebellum during a period of nearly a century, I proceed to a consideration of the facts which lead me to differ from some of the views hitherto advanced.

The Epencephal.

Is the epencephal a distinct brain segment? This is a question which perhaps can not be settled at once.[1] But the writer believes that, as has been stated by Wilder (36, 523), for the purposes of comparative and descriptive neurology it would be a great convenience to regard the epencephal as a distinct brain segment; hence some evidence will be given in support of that view.

In order to reach a logical conclusion we must first decide what constitutes a brain segment. In the case of the primary

[1]In this connection, see also Osborn (25, 490).

vesicles, obviously the tube is dilated in three places and contracted in two places. Then shall we say that a bending in of the walls, so as to constrict the caliber of the tube, is sufficient to demarcate a segment? Why do we not have just as much right to say that the opposite condition, or a bending out and consequent widening of the caliber, demarcates a segment? Or may not also a marked change in the character of the whole or of a part of the walls themselves serve to distinguish one segment from another?

Now if, after development has progressed for a certain time, we carefully examine the third vesicle, we shall find that,—

A. 1. The roof of the cephalic part is composed of substantial nervous parietes.

2. That later *a part* of this roof is clothed with a layer of ectocinerea.

3. At a point a little caudad of the caudal border of the substantial parietes of the roof is formed a bend (pons flexure) which involves the entire brain tube. The result of this flexure is the formation of a transverse groove which extends clear across the tube. The sides are also forced out ecto-laterad in the form of a U-like fold which may be compared to the rolling collar which the tailor sometimes puts upon garments. As a result of these changes it is obvious that the caliber of the tube is widened at this point.

4. The substantial parietes are continuous only in the floor of the cavity. Compare Figs. 4, 5, Pl. I, and Figs. 49, 50, 53, Pl. V.

5. The later growth in this part cephalad of the pons flexure is, (*a*) dorsad, (*b*) laterad, (*c*) ventrad.

B. The part caudad of the flexure is distinguished from the part cephalad by the following characters:

1. The roof is a thin membranous tela and remains so during the life of the individual.

2. It never possesses any ectocinerea.

3. It has no growth dorsad.

4. Its growth is in a ventral and lateral direction only.

From these facts it will appear that while these two re-

gions do constitute a single dilatation of brain tube, they are separated, in the embryo at least, by a flexure which involves the entire brain tube. In their essential characters they are as distinct from each other as is the myel from the cerebrum.

Therefore it seems to me that the epencephal constitutes a definitive segment of the brain, having a floor, roof and sides. The cephalic walls and roof are convex ectad, and concave entad. They may be compared to segments of a hollow sphere, as the skin of an orange. They are the dorso-meso-caudal extensions of the floor on each side whose meso-caudal borders are divaricated, but still united by the thinner deckplate. These semicircular plates are the *Kleinhirnlamelle* of Mihalkovics (22, 53). But it is not probable that anything more than a comparatively narrow strip of their caudal portions develops into the cerebellum. Compare Figs. 1, 4, 6, Pl. I, and Figs. 24a, Pl. III, 42, Pl. IV.

It would appear that these caudal portions or protons are the *corpora restiformia* of Tiedemann (31).

The embryonic epencephal may be described as a segment of the brain tube lying next caudad of the mesencephal. It begins at the isthmus and ends at the pons flexure. Considered apart from the remainder of the brain it is a subcylindrical tube whose cephalic boundary is contracted at the isthmus and the caudal extremity is widened and rolls out something like the bell of a brass horn, with this difference, the rim extends only around the sides and roof. The floor is continuous with that of the metencephal, but is demarcated from it by the pons flexure.

At the isthmus, the tube is constricted to about one half the diameter of the mesencephal; it gradually widens caudad. Thus there results a subcylindrical funnel-shaped tube composed of substantial nervous substance, whose roof and sides are continuous with the metatela.

The tela is joined to the substantial nervous substance around its entire circumference; between the substantial parietes and the tela there is a thinner, transitional margin which gradually merges into the tela. The term *kilos* is proposed to des-

ignate it. If the writer understands His correctly it corresponds to the Rautenlippe. See *kl.*, Fig. 28, Pl. III.

The appearance of the early epencephal is well shown in Figs. 1, 3, 4, 5, 6, Pl. I, and in Figs. 50, 51, 55, Pl. V. In Figs. 1-3, Pl. I, the pons flexure is just beginning to appear. Its further development causes a greater separation of the meso-caudal border of the epencephal till it comes to lie in the position shown in Figs. 4, 5, 6 and 7, Pl. I. These specimens also show the dorso-cephalic rotation of the two lateral protons of the cerebellum; compare also Figs. 31, 35, 37, Pl. III, and Figs. 50, 51, 55, Pl. V.

In order to understand the changes which follow we must consider those which have preceded.

1. The brain tube was once an open groove.

2. The lateral walls of this groove have extended dorso-mesad and fused along the meson. Now we would naturally expect that the sides of the tube would be the thicker and contain potential proliferating elements. Does not this idea explain why the Deckplatte is so thin?

As the pons flexure is developed, the kilos and a part of the substantial wall are forced ectad and in this manner the lateral U-bend is formed. The ectal opening between the two arms of the U is closed by a portion of the original metatela which is thus folded off, and later becomes the dorso-caudal wall of the parepicœle. See Figs. 1, 3, 5, 12, Pl. I, Fig. 60, Pl. VI, and Fig. 65, Pl. VII.

Dorsad of the pons flexure, a fold of the metatela sinks down into the cavity, bloodvessels follow and form a plexus (choroid plexus of the older writers) which extends clear across the brain tube. The place where the fold occurs forms the line of attachment for the plexus; it encircles the dorsal part of the brain tube like a girdle, hence the name *cestus* is proposed for it.

From the foregoing it appears that that portion of the brain tube which lies between the isthmus and the pons flexure presents peculiar characters, such as are not presented by the parts lying next cephalad or caudad of it.

The question which now demands attention is, How much

of the roof of this segment is involved in the development of the cerebellum ?

The adult condition may here be considered. Compare Fig. 24, Pl. III with Figs. 42, 43, 44, Pl. IV. In the adult brain we have as mesal landmarks,

1. The mesencephal and isthmus.
2. The kilos.

Between the structures lie,

a. The valvula.

b. The cerebellum.

At the constriction of the isthmus, there is a thickening in the roof which increases laterad. It is in fact "a transverse plate inclined at a wide angle to the axis of the oblongata." See Fig. 24, Pl. III. Now the universal statement in all text-books on embryology is that this *transverse plate is the cerebellum.* It is true that it does bear a resemblance to the amphibian cerebellum. But if this plate is the cerebellum, *where is the valvula ?* What also is the meaning of the two lateral thickenings, in the caudal part of the roof, which *do not* extend across the meson. See the section shown in Fig. 24 *a*, Pl. III, and also gross preparations shown in Figs. 4, 6, Pl. I, 52, 54, 55, Pl. V. Again what is the meaning of the condition shown in Figs. 8 and 10, Pl. I, and Fig. 58, Pl. VI, where these lateral protons have fused upon the meson ?

The only explanation which the writer, at present, has to offer is this : that the thickening at the isthmus is really less than it appears to be. For, suppose that as a result of the dilatation of the mesencephal its walls become thinner. The effect would be to make the appearance of an isthmus thickening greater than it really is.

The writer believes that the results of his own observations upon the brains of both man and the cat go to show that this so-called transverse plate is not the cerebellum, and that in early embryos the cerebellum does not appear in a mesal section.

The Cerebellum.

Definition.—The cerebellum, in its broadest sense, may be

defined as that part of the epicœlian roof which is clothed with ectocinerea.

In its early stages it consists of two fusiform protons which lie in the latero-caudal convexity of the roof of the epencephal just cephalad of the kilos and are twisted so as to conform with the general outline of the walls. In the stage shown in Figs. 6 and 7, each extends from near the floor successively cephalad, dorsad, caudad, mesad, and again cephalad and ends at a notch in the roof situated at about one fourth the distance from the meson to the lateral border and forms the cephalic arm of the U-bend. In Fig. 5, a younger embryo, the proton and adjacent parietes are folded over ecto-cephalad. Compare Figs. 7, 29, 32, 50, 51, 52, 53.

The further development appears to be a process of proliferation, by which these lateral protons are extended dorsad, cephalad, and mesad. The mesal extension meets its opposite at the meson and fuses therewith. From now on we have to deal with a single structure instead of with two. Reference to Figs. 42 and 43, Pl. IV, shows that the dorsal extension at the base is not as wide as might be expected, but that the organ widens as it extends dorsad. This is still more apparent in human embryos. The result of this method of growth is the spreading, umbrella-like appearance so characteristic of the adult organ.

The transition from the condition shown in Figs. 4, 5, Pl. I, and in Figs. 52, 53, Pl. V, to that shown in Figs. 8, 9, Pl. I, and 58, 59, Pl. VI, is very surprising. The explanation which seems most reasonable to me, is that during the process of growth the cerebellum, still thin at the meson, and quite flexible, becomes rotated caudo-ventrad, or folded upon itself; and in this way the ripa is brought from the position it occupies in Fig. 52 to that shown in Fig. 58. It seems to me that the specimens shown in Figs. 35, 36, 37, Pl. III, in Figs. 42, 43, Pl. IV, and in Figs. 56, 57, Pl. V, support this view.

His (15, 22) has a different idea. He says, "Die Oberfläche des Kleinhirns verwächst mit dem sie berührenden Theile der Deckplatte, an Stelle der primären vor dem Cerebellum befindlichen Taenia, entsteht eine secundäre vom hintern Rande

sich ablösende und die sackartige Hülle welche das Kleinhirn noch im Beginn des 3 Monats bessen ist später spurlos verschwunden."

The writer fails to obtain any such idea from his own specimens.

Main Divisions of the Cerebellum.—The dorsal aspect of comparatively late embryos presents one mesal and three pairs of lateral regions, viz:

1. The vermis, azygous.
2. The pilea, paired.
3. The paraflocculi, paired; in the lower mammals, each is divided into supraflocculus and mediflocculus.
4. The flocculi, paired.

Of these the vermis is the last to appear, as might be expected from the method of development.

The Pilea.—The regions which form the pilea apparently are the first to be formed. Compare Figs. 8, 10, 56, 58. In the adult cat they form quite prominent masses but receive their highest development in man, where they form the chief mass of the entire cerebellum.

Their development is briefly as follows: Beginning with the stage shown in Figs. 8 and 9, there are two lateral sub-ovate masses, joined at the meson by a thin plate of substantial parietes; compare with Figs. 2, 4, 6, 52 and 58. On the lateral aspect there is a slight depression which evidently foreshadows the division into pileum and paraflocculus. The successive changes are more readily traced in the cat because the enormous human pileum obscures adjacent parts.

The first distinct demarcation is into pileum and paraflocculus by the parafloccular sulcus. This shows clearly in Fig. 11. At a later stage, shown in Figs. 12, 13, and best in 14, a new sulcus has appeared which divides the pileum into two regions, prepileum and postpileum. The postpileum is very small in Fig. 13, but it rapidly increases till it fully equals, if it does not exceed, the prepileum; see Fig. 17. After this stage the prepileum grows rapidly till in the adult it is very large and well developed, while the postpileum appears quite insignificant (Fig.

23). Contrast with the condition in man where the postpileum forms the chief mass of the postramus. See Figs. 70-75.

From the great size of the pileum, its amount of cortex, and its intimate connection with the myel caudad and the cerebrum cephalad, it would seem that it must be in some way correlated with man's superiority or erect attitude.

In the lower mammals, the prepileum is the larger.

The paraflocculus.—A general idea of the paraflocculus of the lower mammalia can be obtained from a study of the cat's cerebellum. It is a large, richly foliated structure lying between the prepileum and the flocculus and apparently of great functional value. It is divided into two lobes—the suprafloccu-lus dorsad, and the mediflocculus ventrad—by the deep interfloccular sulcus. The supraflocculus is connected with the postpileum by substantial nervous substance. This connection is obscured in the adult by the superficial development of the adjacent parts.

In man, on the contrary, it is variable, small, and would seem to be a degenerated structure of comparatively unimportant functions. In him it is foliated, but I do not feel certain that there is a proper division into supra- and mediflocculus; it appears to be larger in the embryo than in the adult.

The same connection with the postpileum appears to exist in human embryos, but in the adult it is even more obscure than in the cat. Compare Figs. 17, 19, 22, 23, 58, 60, 71, 75.

The mesal connection of the mediflocculus with the postvermis is clearly shown by the ridge of nervous matter, the vermian tract, an enormous bundle of fibers; it is not readily recognized in the adult, but appears in Figs. 17, 19, 65, 71.

In general it may be said that the adult cerebellum in both man and the cat presents such a plump and compact superficial development that many of the embryonic features are recognized with difficulty.

The flocculus.—In both man and the cat the flocculus proper is foliated and would appear to have about the same morphological significance. It arises from the caudo-lateral part of the roof, between the paraflocculus and kilos; Figs. 17, 18, 58, 60,

61, show its early form and the method of its development. In man, the lateral portions of both flocculus and paraflocculus form the chief mass of these structures. They are compressed and forced laterad by the enormous growth of the postpileum which finally overshadows and dwarfs them. Their mesal extensions are submerged by the growth of adjacent parts; they apparently exist only as bundles of fibers running to the postvermis, imbedded in the foundation mass of alba. Compare Figs. 65, 70.

The rami.—If we retain the old idea of comparing the cerebellum to a tree, the mesal aspect shows that it consists of two enormous branches —preramus and postramus. The postramus is much the larger.

The preramus.—It appears that at an early stage of development a deep transverse cleft — the furcal sulcus — appears. It divides the cerebellar mass into two unequal portions. The preramus, the cephalic, is the smaller and forms the cephalo-mesal portion of the organ, which lies cephalad of the furcal sulcus. See Figs. 64, 66, 67, 74. It is relatively much smaller in the lower mammals than in man. The preramus includes the regions recognized as, (1) lingula, (2) cephalic lobe, (3) central lobe, (4) culmen, and their lateral extensions.

The postramus.—This includes the remaining and by far the greatest mass of the cerebellum. It comprises the following mesal parts and the lateral masses connected with them, viz., (1) the clivus, (2) the cacumen, (3) the tuber, (4) the pyramis, (5) the uvula, (6) the nodulus.

In man the clivus and its lateral prolongations constitute the prepileum. In the cat, the clivus, the cacumen, and the tuber with their lateral extensions constitute the prepileum. In man the peduncular sulcus separates the the pre- from the postpileum; but the peduncular sulcus of man does not correspond to the interpilear sulcus of the cat.

For an idea of the extent and mass of the prepileum in man consult Figs. 67 and 66, or the part lying cephalad of the peduncular sulcus.

The postpileum comprises the remaining five lobes of the

postvermis and their lateral prolongations. For the extent and relative mass of these in man consult Figs. 64, 66 and 67, and in the cat Figs. 20, 23 and 44.

Summary.

The following points are believed to be new or little known.

1. Some ideas about the epencephal as a definitive brain segment.

2. The mammalian cerebellum is developed from the caudal part of the epicœlian roof.

3. The definition of the cerebellum as "that part of the epicœlian roof which is clothed with ectocinerea."

4. The existence of paired notches in the caudal part of the epicœlian roof. See Fig. 6.

5 An explanation of the shifting of the ripa ventrad.

6. The non-appearance of the cerebellum on a mesal section of the early embryo brain.

7. That the lateral parts are formed first, although, as stated by previous observers, they do not receive their adult foliation till after the mesal sulci have appeared.

8. That mesal sulci appear before the vermis, as a distinct lobe, is formed.

9. The late appearance of the vermis.

10. A new topographic terminology for the cerebellum.

11. The recognition of new sulci:

a. The floccular sulci, paired at first, but fused at the meson later.

b. The parafloccular sulci, paired, but not fusing.

c. The interfloccular sulci, paired, but not fusing.

d. The interpilear sulci, paired, but not fusing.

These are best seen in the embryo.

12. The first sulci appear on the lateral parts, *not on the vermis, as has been previously stated.*

13. The existence of the interpileum marking the mesal limit of the interpilear sulcus.

14. The non-correspondence of the peduncular sulcus in man with the interpilear sulcus of the cat.

15. The recognition of a new lobe, the cephalic lobe, in the prevermis.

16. The division of the postramus into two regions, pre- and postpileum, apparently different in man and the cat.

17. The recognition of the flocculus and paraflocculus as distinct regions, common to all mammals.

18. The division of the paraflocculus in the lower mammals into two parts, supra- and mediflocculus.

19. The connection of the supraflocculus with the postpileum and of the mediflocculus with the postvermis.

20. The recognition of the vermian tract, a distinct ridge in some of the lower mammals, a bundle of fibers imbedded in the foundation alba, in some of the higher.

21. The difference in size and apparent relative functional importance of the paraflocculus in man and the cat.

22. The cestus.

23. The kilos.

24. The development of the auditory eminence.

25. The multiple character of the auditory nerve in its development.

26. The lateral U-bend.

27. The caudal fold.

28. The structure of the metepiplexus.

29. The caudal extension of the mesencephal.

30. The presence of transitory foldings in the roof of the mesencephal.

31. The caudal tip of the mesencephal is bifurcated in the cat, pointed in man.

32. The homology of the different parts of the cerebellum in man and the cat.

33. In the cat, the pyramis is rudimentary.

34. In man the cephalic part of the cerebellum becomes foliated before the caudal part.

35. The identity of the kilos and postvelum.

New Terms Defined.

Cestus.—Lat. *cestus,* a girdle, Gr. *kestos,* stitched, embroidered. The band-like line of attachment of the metepiplexus. It surrounds the dorsal part of the brain tube like a girdle.

Interpileum.—Lat. *inter,* between, and *pileum,* a cap. In the embryo kitten, a slight elevation between the interpilear and the uvular sulci. Figs. 15 and 16.

Kilos.—Gr. *cheilos,* a lip, rim. The thin zone of nervous substance which forms the transition between the substantial parietes and the metatela.

Pileum.—Lat. *pileum,* a cap. A lobe of the cerebellum lying between the vermis and the paraflocculus. Its relation to the peduncle is like that of a cap.

Pugnus.—Lat. *pugnus,* a fist. An especial development of the mediflocculus inclosed in a cell in the petrous bone, in Rodents, some Carnivora, *Chiromys,* monkeys, and some other mammals. Named from its resemblance to a fist. [The "appendicular lobe" of the older anatomists.]

CORNELL UNIVERSITY,
ITHACA, N. Y., May 1, 1895.

BIBLIOGRAPHY.

1. 1877. ALIX, E. Sur le cerveau à l'état foetal. *Bul. Soc. d' Anthropol.,* 2 S., XII, pp. 216-225.
2. 1888. BECHTREW, W. Ueber die bestandtheile des vordern Kleinhirnschenkles. *Arch. f. Anat. u. Phys.,* Anat. Abth., 195-204, Taf. XIII.
3. 1826. BURDACH, K. F. Bau und Leben des Gehirns. III. *Leipzig.*
4. 1890. CAJAL, S. RAMON Y. Apropos de certains éléments bipolares du cervelet avec quelques details noveau sur l' evolution des fibers cerebelleuses. *Intern. Monatsschr. f. Anat. u. Phys.,* VII, p. 447-468.
5. 1870. CALLENDER, G. W. Description of a foetal brain. *Jour. Anat. and Phys., London,* 1870, IV, 247-255.
6. 1874. CALLENDER, G. W. Formation and early growth of the brain of man. *Brit. Med. Jour., London,* 731, 763, 795.
7. 1814. CARUS, KARL GUST. Versuch einer Darstellung der Nervensystems u. insbesondere des Gehirns nach ihre Bedeutung, Entwicklung, und Vollendung. *Leipzig.*
8. 1814. DOELLINGER, IGNAZ. Beiträge zur Entwicklungsgeschichte des menschlichen Gehirn. *Frankfort, a. M.*
9. 1889. EDINGER, L. Structure of the Central Nervous System. 2d. ed.

10. 1877. FERE, C. Contribution à l'étude du developpement du cerveau considére dans ses rapports avec le crane. *Progrès. Méd., Paris.*

11. 1893. FISH, P. A. A new clearer for collodionized objects. *Proc. of Amer. Micros. Soc.*, XV, 86-89.

12. 1884. GAGE, S. H. The application of photography to the production of natural history figures. *Science*, III, 443-444, 2 figs., Apr. 11.

13. 1891. HERRICK, C. L. Morphology of the central nervous system. I. Illustrations of the archetectonic of the cerebellum. *Jour. Comp. Neurol.*, I, March, p. 5-14, Pl. I-IV.

14. 1874. HIS, WILHELM. Unsere Körperform. *Leipzig.*

15. 1891. HIS, WILHELM. Die Entwickelung des Menschlichen Rautenhirns. *Leipzig.*

16. 1892. HIS, WILHELM. Zur allgemeinen Morphologie des Gehirns. *Archiv f. Anat. u. Phys.*, Anat. Abth., 346-83.

17. 1893. HIS, WILHELM. Vorschläge zur Eintheilung des Gehirns. *Arch. f. Anat. u. Phys.*, p. 172.

18. 1890. HERTWIG, OSCAR. Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbelthiere. *Jena.*

19. 1865. KRISHOBER. Considerations sur le développement de l'encéphale. *Union méd., Paris*, 2 S, XXVII, 586-588.

20. 1878. KOELLIKER, ALBERT. Entwicklungsgeschichte. *Paris.*

21. 1888. LAHOUSSE, E. Recherches sur l' ontogenèsis du cervelet [of the fowl]. *Arch. de Biol.*, VIII, 47-110, Pls. IV-XI.

22. 1877. MIHALKOVICS, VICTOR V. Entwicklungsgeschichte des Gehirns. *Leipzig.*

23. 1876. MIHALKOVIS. G. Vizsgalatok az agyboltozat, kérges test és átlátszo sövények fejlodeséröl [On the development of the brain]. *Orvosi hetil., Budapest*, XX, 685, 705, I Pl.

24. 1892. MINOT, CHARLES SEDGEWICK. Human embryology. *New York.*

25. 1887. OSBORNE, HENRY F. The relation of the dorsal commissures of the brain to the formation of the encephalic vessicles. *American Naturalist*, Oct., p. 940.

26. 1879. PAROTT, J. Du developpement de l'encéphale chez l'enfant dans la première année. *Gaz. Méd. de Paris*, 6. s, I, 204.

27. 1893. SCHAEFER, E. A. Quain's Elements of Anatomy, 10 ed. *London*, 1892-3.

28. 1894. SCHAPER, ALFRED. Die Morphologische und histologische Entwickelung des Kleinhirns der Teleostier. *Anat. Anzeiger*, IX, 16, June.

29. 1815. SERRES, E. R. A. —— —— *Meckel's Archiv*, I, pp. 77-107.

30. 1824. SERRES, E. R. A. Anatomie comparée du cerveau dans les quatres classes des animaux vertébrés. *Paris.*

31. 1816. EIEDEMANN, FREDERIC. Anatomie und Bildungsgeschichte des Gehirns im Fötus des Menschen. *Nürnberg.*

32. 1893. VAN GEHUCHTEN, A. Le système nerveux de l'homme. *Lierre.*

33. 1812. WENZEL, IOS. ET CAR. De penitiori structura cerebri hominis et brutorum. *Tübing.*

34. 1872. WILDER, B. G. On the cerebellum of the lower vertebrates. *The Cornell Era*, Apr. 12.

35. 1884. WILDER, B. G. The Cartwright Lectures on the methods of studying the brain. *New York Medical Journal*, Feb.

36. 1884. WILDER, B. G. Do the cerebellum and oblongata represent two encephalic segments or only one? *Proc. American Assoc. for Advancement of Science*, XXXIII, p. 523, September.

37. 1889. WILDER, B. G. Gross anatomy of the brain. *Reference Handbook of the Medical Sciences, New York*, Vol. VIII.

38. 1877. ZUCKERKANDL, E. Beitrag zur Morphologie des Gehirns. *Zeitschr. f. Anat. u. Entwicklungsgscht., Leipzig*, ii, 442–450. I, Pl.

DESCRIPTION OF PLATES.

NOTE.—The length for embryos is that from the top of the head to the vent. The magnification of figures is given in the explanations, except for Plates III and IV, where a line of given length indicates the enlargement.

The preparation of specimens has been after the method given in the introduction.

Heavy black lines represent either (*a*) the cut edge of endyma, or (*b*) the cut or torn edge of a tela consisting of the endyma and pia conjoined.

The occasional disregard of the rules formulated by Wilder (Handbook, IX, 120, 56) was due sometimes to inadvertence, sometimes to the condition of the specimen, the right side being either more perfectly preserved or alone available.

The number of a given specimen refers to the accession number of the Museum Vertebrate Zoology of Cornell University.

ABBREVIATIONS.

cac.—cacumen.
cr.—crus.
cbl.—cerebellum.
cb.—cerebrum.
cdl. fd.—caudal fold.
ch. pl.—choroid plexus.
cl.—clivus.
crnl. flx.—cranial flexure.
cst—cestus.
cul.—culmen.
dent.—dentatum.
d. fd.—dorsal fold.
Dien.—diencephal.
dpl.—Deckplatte of His.
Em. au.—auditory eminence.
epcl.—epicœle.
Epen.—epencephal.
epnd.—ependyma.
mttl.—metatela.
mylcl.—myelocœle.
n.—nodulus.
nk. flx.—neck flexure.
nod. s.—nodular sulcus.
olv.—oliva.
obl.—oblongata.
parepcl.—parepicœle, lateral recess of the cerebellum.
paraflc.—paraflocculus.
paraflc. s.—parafloccular sulcus.
plm.—pileum.
pdcl.—peduncle.
postplm.—postpileum.
preplm.—prepileum.
P. or pn.—pons.
pym.—pyramis.
py.—pyramid.

eptl.—epitela.
flc.—flocculus.
flc. s.—floccular sulcus.
frcl. s.—furcal sulcus.
gm.—gemina.
isth.—isthmus.
kl.—kilos.
l. ct.—central lobe.
lng.—lingula.
l. U-bd.—lateral U-like bend.
mediflc.—mediflocculus.
mesen.—mesencephal.
meten.—metencephal.
mscl.—mesocœle.
mtcl.—metacœle.
mtpr.—metapore.
pvl.—postvelum.
pvm.—postvermis.
p. flx.—pontile flexure.
plx.—plexus.
rf. pl.—roof plate.
rp.—ripa.
Rg. au.—auditory region.
supraflc.—supraflocculus.
st.—stem.
sl. cl—saddle cleft.
tl.—tela.
trans. s.—transitory sulci.
uv.—uvula.
vl.—velum.
vm. tr.—vermian tract.
vlv.—valvula.

PLATE I.

Fig. 1. Left lateral aspect of the caudal three brain segments and myel of an embryo pig 16 mm. long, No. 3337 (x 7.5).

The specimen had been preserved in alcohol; the cephalic two-thirds of the cerebrum had been sliced off by a previous inquirer. Shows,

a. The large subspherical mesencephal.

b. The contracted isthmus which has only about one half the diameter of the mesencephal.

c. The convex flaring walls and roof of the epencephal; the roof arches dorso-cephalad.

d. The expanded metatela (roof or *deckplate*) and its lateral extension caused by the pontile flexure. (This extension forms the caudal wall of the adult parepicœle. See also Fig. 3.)

e. The cranial flexure (head bend), saddle cleft, bend of the pons, and a concavity in the metatela which later becomes a fold, the dorsal fold, Fig. 5.

f. The left lateral proton or rudiment of the cerebellum, *cbl.*

Fig. 2. Dorsal aspect of the same specimen. Shows,

a. The ovöid appearance of the mesencephal at this period.

b. The constricted isthmus.

c. The elongated shield-shaped metatela and its lateral extensions which later form a part of the paracœlian wall.

d. The two lateral protons of the cerebellum. Compare Figs. 24 and 24 *a*, Pl. III.

e. The roof of the epencephal. Its extent is shown better in Figs. 1 and 3.

Fig. 3. Oblique view of the same specimen. Shows the same features as Figs. 1 and 2, but gives a better idea of the isthmus and the cephalic termination of the metatela.

Figs. 4 and 5. Epencephal of an embryo kitten 18 mm. long, No. 3338 (x 15). *Fig.* 4, dorsal aspect, shows,

a. General form of the epencephal, constricted at the isthmus, widened caudad.

b. The roof-plate (or *deckplate*) which being thinner than the lateral parts of the roof has been forced dorsad in the form of a longitudinal fold as the brain hardened and contracted slightly.

c. The lateral U-like bend of the substantial parietes which projects laterad from the brain tube and has resulted from the folding of the tube upon itself at the pontile flexure. It appears to have been formed as a result of the flexion of the tube and the concomitant growth of the parts concerned, so that there results a U-shaped bend which projects laterad like an ear from the brain tube. *Fig. 5* shows the lateral aspect of the bend.

d. The two lateral protons of the cerebellum which have not yet fused at the meson. It is interesting to note that these two structures have rotated so that they stand up dorsad at nearly right angles to the brain tube. See Figs. 29, 30, 31, Pl. III.

e. The caudal fold which is formed as a result of the lateral U-bend, *cdl. fd.* The lateral wall is doubled upon itself, so that a fold is projected entad and in this manner forms the floor of the parepicœle, and apparently develops into the auditory eminence of the adult. I have indicated this structure in the earlier embryos by the term *auditory region.* See Figs. 8, 10, 12, 13, Pl. I, Fig. 35, Pl. III, and Figs. 52, 53, 54, Pl. V.

f. The relations of the tela which forms the roof of the metacœle and the dorso-caudal wall of the parepicœles. The tela has been torn away on the left side so as to expose the cavities and the ental surface of the cerebellum. The heavy black line represents the ripa, the torn edges of the tela. The membranes are shown entire on the right side.

Fig. 5. Shows the lateral aspect of the same embryo. The mesencephalic roof is seen to extend both cephalad and caudad. The caudal extension rapidly increases, so that in embryos a little older, it reaches almost to the caudal border of the epencephal. The dorsal fold of the metatela which dips down deep into the metacœle is also clearly shown. Compare Figs. 31 and 33, Pl. III, *mtplx.*

Figs. 6 and 7. Embryo kitten 23 mm. long, No. 3339 (x 15). Shows the same general features as Figs. 4 and 5, and in addition,

a. The still greater caudal extension of the mesencephalic roof.

b. The increased size of the two protons of the cerebellum which have not yet fused at the meson. A peculiar notch or fold marks their mesal extremity. This notch is, perhaps, an artifact due to the shrinking of the brain during hardening. The caudal (ental) surfaces of the cerebellum are not shaded to represent them more clearly, but it must be remembered that they are covered by the tela and are therefore within the proper brain cavity (*i. e.*, they are entocœlian surfaces). For the sake of clearness, the kilos and the ripa or the line where the kilos ends and the metatela begins have not been shown. The ripa is approximately just caudad of the place where the shading ends. The line caudad of the shading represents the line of the attachment of the

plexus to the tela. It extends around the lateral and dorsal sides of the brain tube like a girdle, therefore the term cestus (*cst.*) is proposed to indicate it. This is a very interesting specimen and apparently presents a condition identical with that shown in the human embryos, Figs. 52 to 55, Pl. V.

Fig. 7. Shows the left lateral aspect of the same specimen; here the auditory region is quite large, the cestus shows clearly and the plexus may be dimly seen through the thin semi-transparent tela.

Figs. 8 and 9. Embryo kitten 40 mm. long (x 11), prepared by Dr. P. A. Fish. Shows,

a. The caudal extension and bifid extremity of the mesencephal. This appearance is very characteristic.

b. The lateral protons of the cerebellum have now fused at the meson. It seems probable that the change has been brought about in the following manner. Each lateral proton has grown by an increase in thickness and has gradually extended itself by a sort of proliferation cephalad, dorsad, and *mesad* till at last it has met the proton of the opposite side of the brain tube at the meson and has fused with it. Thus the deckplate has been obliterated. From now on we have to deal with a single structure instead of with two. The lateral portions, however, have a much greater mass than the middle part which is still thin. This relative proportion continues for some time. The vermis of the adult cerebellum is comparatively late in its development. The remaining parts are self explanatory.

Fig. 9. Shows the left lateral aspect of the same specimen. There is a small elevation at the cephalo-lateral extremity which shows that the prepileum has begun to be differentiated, but the entire region of the pre- and postpileum is indicated under the general term *pileum.* A shallow furrow marks the floccular sulcus. The other parts are self explanatory.

Figs. 10 and 11. Embryo kitten 36 mm. long, No. 3340 (x 15). *Fig. 10* shows the dorsal aspect of the cerebellum which has now begun to be differentiated into regions which persist through life. It appears that the earlier changes begin laterad and proceed mesad. From an examination of the surface the mesal part appears to be still quite thin. At this stage at least two of the primary furrows have appeared. In the lateral regions two elevations separated by a shallow furrow — the parafloccular sulcus — have appeared. These elevations constitute the pileum and the paraflocculus, shown in profile in Fig. 10. Fig. 11 shows a face view. The floccular sulcus extends transversely clear across the cerebellum. Dorsad of it there is a slight narrow depression which probably represents the later nodular sulcus. At this stage there is a dorso-caudal extension of the cerebellum; at the meson there is a distinct notch, barely perceptible in Fig. 8. It shows very clearly in Fig. 13. Fig. 10 also shows the kilos, cestus, tela, and plexus quite clearly.

Fig. 11. Shows the first real demarcation of the cerebellum into distinct regions, the pileum and the paraflocculus. A little later the pileum is divided into two regions, prepileum and postpileum, by a new sulcus the interpilear sulcus. See Fig. 15, Pl. II. Fig. 11 also shows the floccular sulcus, the kilos, the parepicœle, and the plexus which shows through the tela. During the dissection the tela was torn away from the kilos. Its lines of attachment is in-

dicated by the heavy black line, *rp*. The auditory region shows a marked increase in size. At this stage the paraflocculus is larger than the prepileum. The figure does not show the cerebellar peduncle which is just beginning to form. See Fig. 14.

Fig. 12. Shows the dorso-caudal aspect of the cerebellum of an embryo kitten 53 mm. long (x 7.5). This is practically the same condition as that shown by a human embryo, Fig. 60, pl. VI. The mesal part of the cerebellum is still quite thin, and four distinct furrows are present. The nodular sulcus is unmistakable and in addition to the parafloccular sulcus, a new furrow, the interpilear sulcus, has appeared. There is a corresponding sulcus upon the other side of the cerebellum. These sulci do not cross the meson and apparently do not become continuous with any of the mesal sulci which appear later. The interpilear sulcus divides the pileum into two regions which appear to be distinct through life. The parepicœle and caudal fold are shown very clearly. The specimen is turned at such an angle that the caudal projection of the cerebellum does not show. Tela and plexus have been removed. The heavy black line indicates the ripa.

Figs. 13 and 14. Cerebellum from an embryo kitten about 55 mm. long, No. 3341 (x 7.5). Shows a later stage of development; two new furrows are present—the furcal sulcus and the uvular sulcus. I have not been able to obtain specimens to show which one appears first. But the adult condition indicates that it is the furcal. See Fig. 44, Pl. IV. The furcal sulcus divides the mesal portion of the cerebellum transversely into two unequal parts. For reasons to be stated elsewhere we shall call all of the organ which lies cephalad of the sulcus *preramus*, and all that lies caudad *postramus*. In addition to the features just noted the figure shows essentially the same parts as Fig. 12.

Fig. 14. Left lateral aspect of the same specimen. Shows very clearly the caudal extension of the mesen. Compare Figs. 1, 5, 7, 9. The peduncle of the cerebellum is now recognizable. The specimen also shows the relation of the interpilear sulcus to the parafloccular sulcus and the relation of the prepileum to the postpileum; the former now has a volume greater than that of the paraflocculus. The kilos, ripa, and plexus show plainly.

PLATE II.

Figs. 15 and 16. Cerebellum of an embryo kitten 63 mm. long, No. 3342. (x 7.5). Shows practically the same features as Figs. 13 and 14, Pl. I. In addition to these there appears a slight elevation surrounded by a very shallow groove,[1] the interpileum. (This term was suggested by Professor Wilder.) The structure forms an interruption between the interpilear and the uvular sulci. At present I am unable to explain its significance, but shall discuss it in a future paper, as soon as enough material is available. The mesal shading indicates a depression extending cephalo-caudad.

Fig. 16. Left lateral aspect of the same specimen.

1 The lines surrounding the interpileum in Fig. 15 should not have been quite so heavy. They represent only a very shallow groove, not a sulcus.

Figs. 17, 18, 19. Cerebellum of an embryo kitten 77 mm. long, No. 3443 (x 7.5).

Fig. 17. Shows the dorsal aspect. The organ presents numerous folia and begins to assume distinctly adult characters. At this stage the vermis may be recognized but it still presents a mesal depression. Upon each side there is a rather wide depression which becomes the vallecula of the adult. The brain was somewhat distorted in hardening; this is an advantage because it allows the left flocculus and paraflocculus to be seen from the dorsal aspect. A depression is seen in the paraflocculus, the interfloccular sulcus. It divides the paraflocculus into two parts, of which at Professor Wilder's suggestion, I have called the dorsal part, supraflocculus, and the ventral part, mediflocculus.

The flocculus proper is not differentiated as early as the paraflocculus. This is the youngest specimen that shows it clearly. The early embryos show an apparent connection between the supraflocculus and the postpileum. The same condition exists in the adult but is obscured by the great development of the adjacent parts. An attempt will be made in Part II to trace the fiber relations of these two regions. A connection also exists between the floccular region (flocculus and paraflocculus) and the postvermis. I get this idea from dissections of adult cerebellums. This connection is indicated by the term vermian tract.

A considerable portion of the preramus and its middle part, the prevermis, is seen, also the relations of the furcal sulcus and the peduncular sulcus, next caudad. The entire mass from the peduncular sulcus caudad to the uvular sulcus represents the cacumen and the tuber. The cacumen in the cat is relatively much larger than in man. The remaining part of the postvermis, shown in the figure, represents the uvula. The pyramis is rudimentary in the cat. See Fig. 44, Pl. IV. The floccular and nodular sulci do not appear in this aspect.

Fig. 18. Right lateral aspect of the same specimen; the right aspect was drawn because the left was distorted. In additition to the general features it shows the lateral U-bend and its relation to the parepicœle, the auditory region, and the auditory nerve.

Fig. 19. Shows an oblique view of the same specimen (x 11.5). Shows the relation of the supraflocculus to the postpileum, also that of the flocculus and paraflocculus to postvermis, by means of the vermian tract. The other parts need no explanation.

Figs. 20, 21, 22. Cerebellum of an embryo kitten 93 mm. long, No. 3344, (x about 6.7). This specimen shows all the features of the adult organ but in a much more simple condition. The individual regions do not show that crowding together and distortion which in the adult organ are so puzzling. From now on the growth appears to be an elevation of the general surface, not including the primary sulci.

The vermis presents no mesal depression, but instead a mesal elevation. All the mesal parts present in the adult may now be recognized. The postpileum has undergone an enormous change, both in relative size and in general appearance. Its long axis has changed to a latero-cephalic direction; it has also been crowded dorso-caudo-mesad so that it has come to lie up against the postvermis, and now is much thicker than wide. The nodulis is concealed by the uvula.

The entire mass of the prepileum has increased so that now it is greater than that of the postpileum. It has also expanded and the caudal part has extended both laterad and caudad. The supra- and mediflocculus have become foliated, but more folia appear at a later stage; compare Fig. 23, while no folia have as yet appeared upon thè flocculus.

Fig. 21. Lateral aspect of the same specimen. Shows clearly the preramus and its vermis.

Fig. 22. Oblique view of the same specimen intended primarily to show the relation of the floccular region to the postvermis by way of the vermian tract and also that of the postpileum to the supraflocculus.

Fig. 23. Left lateral aspect of an adult cat's cerebellum, No. 153 (x 2.3). Shows the compact and pump appearance of the adult organ. It looks as though the skull had been too small for it. The great size of the vermis is very marked. Compare Figs. 15, 17, 20, 22. The increase in size of the prepileum over that of the postpileum is astonishing. Compare Figs. 11 and 14, Pl. I, and Figs. 16, 17, 18, Pl. II. Note also the comparative size of the flocculus and of the medi- and supraflocculus, and its relation to them.

The flocculus is really larger than it appears to be here, being partially concealed by the mass lying dorsad ot it. In addition, note the relation of the parepicœle to the auditory eminence, the flocculus, and the plexus. The heavy black line represents the torn edge of pia and endyma, the ripa. A portion of the tela was removed to expose the cavity. Compare Figs. 4, 5, 11, 12, 14, Pl. I, and Figs. 18, 19, 20, 22, Pl. II.

PLATE III.

Figs. 24 and 24a. Sagittal sections through the mesencephal, the epencephal, the metencephal and a part of the myel of an embryo pig 16 mm. long, the same age as Figs. 1, 2, 3, Pl. I. The sections were cut a little obliquely and the mesal aspect of Fig. 24 is reconstructed from several sections.

Fig. 24 shows a very rudimentary condition of the parts, also the following distinct features, viz.,

a. The comparatively thick floor of the brain tube; it becomes thinner in the floor of the diacœle.

b. The roof is thin at the meson but thickens laterad.

c. The thin metatela and thicker roof of the epencephal and mesencephal. The change from tela to epicœlian roof is through a region of transition, the kilos, which consists essentially in a decreased thickness of the parietes. This is more abrupt and clearly defined in older embryos.

d. The constriction at the isthmus. At this point there is a greater thickening in the roof which increases laterad. At present I am unable to explain this condition; would suggest that, as a result of the dilation of the mesecephal and a possible contraction at the isthmus, the difference in thickness has been brought about. I shall discuss this subject as soon enough as material is available. Compare Figs. 1, 2, 3, Pl. I, and Fig. 24*a*, Pl. III, which is a sagittal section at some distance from the meson. The proton of the cerebellum is marked *cbl.*; it does not appear in a mesal section. The other parts are self explanatory.

Figs. 25, 26, 27, 28 are oblique transections of the brain of an embryo kitten about 12 mm. long and show a very early condition, a little farther advanced however than Figs. 24 and 24*a*. The sections are as nearly transections as I could cut them; but every one knows how difficult it is to section so small an embryo exactly at right angles to the meson.

Fig. 25. Section through the isthmus. The left side includes a little of the mesencephal. It also shows the thickening of the wall at the isthmus and the general arrangement of the brain at this point.

Fig. 26. A transection through the epencephal cephalad of the cerebellum.

Fig. 27. A transection through the cerebellum; includes the cephalic part of the lateral U-bend. Compare Figs. 5 and 7, Pl. I. This stage of development is of the highest morphological interest because it shows,

a. That the lateral parts of the caudal portion of the epicœlian roof are thick, while the mesal part is thin at the deckplate.

b. The lateral parts are clothed with cinerea which *does not* extend across the meson (compare Figs. 4 and 6, Pl. I); this proves conclusively that the cerebellum is developed from the two lateral areas, or protons, which by a kind of proliferation gradually extend mesad till they form a continuous thickened mass.

The dorsal projection at the meson is an artifact due to collapse of the brain during the process of hardening and infiltrating with collodion. The line laterad of the U-bend represents the tela which forms the lateral wall of the parepicœle.

Fig. 28. A transection of the same embryo through the mesencephal, showing the general character of the metatela and kilos.

Figs. 29, 30, 31, 33, are sagittal sections of the epencephal of an embryo kitten 18 mm. long.

Fig. 29 is a section near the lateral extremity of the lateral U-bend and shows,

a. The parepicœle.

b. The beginning of the plexus.

c. The extreme lateral end of the cerebellum and the auditory region.

d. The relation of the kilos and tela to the cerebellum at this extreme lateral point. Compare Figs. 4, 5, 6, Pl. I, also Figs. 50, 53, and 54, Pl. V.

Fig. 30 is a section a few microns farther mesad. It shows essentially the same conditions as Fig. 29.

Fig. 31. Section still farther mesad. Shows,

a. The dorsal rotation of the cerebellum to a position nearly at right angles with the brain axis.

b. The kilos both at the caudal (here dorsal) edge of the cerebellum and around the edge of the metencephal.

c. The metaplexus.

The condition here is apparently comparable to that found in certain reptiles, Herrick (13, 7). The black line, endyma, is a continuation of the cells forming the plexus.

Fig. 33. Shows the mesal aspect of the same specimen. Note the general

arrangement of the parts, and the great reduction of the roof at the meson. Compare Figs 4 and 6, Pl. I.

Fig. 32. A transection through the lateral U-bend of the same specimen. After the meson had been passed, the tissue was removed from the block and its position changed so as to cut transections of the remainder. It shows the relation of the bend to the brain tube and that of the tela to the bend.

Figs. 34 and 35. Sagittal sections through the cerebellum etc., of an embryo kitten 23 mm. long.

Figs. 36 and 37. Sagittal sections through the cerebellum of an embryo kitten a little older than the previous one. It had been partly dissected by a previous observer, so that the exact length could not be determined. This shows a condition which would seem to indicate that the cerebellum, after having rotated dorso-cephalad, again rotates caudo-ventrad. The condition found in still older embryos would appear to support this view. See Figs. 42 and 43, Pl. IV.

His (15, 22) holds a different view. He says that the "tela grows fast to the apposed ental surface of the cerebellum." But it seems to me that the facts disprove this statement. See discussion on p. 94 of text.

Figs. 38 and 39 show transections through the cerebellnm of an embryo kitten 45 mm. long.

Fig. 38. Section through the caudal part of the cerebellum. It shows,

a. The tips of the overlying mesencephal. Compare with Figs. 6 and 8, Pl. I.

b. The structure of the cerebellum as a substantial mass of alba clothed with ectocinerea, forming a part of the roof of the epicœle ; it is the roof at this particular point. Compare with Figs. 10 and 11, Pl. I ; also with Figs. 27, 33, 35, 37, Pl. III.

c. The epicœle and epiplexus, the metacœle and metaplexus. In this figure the two plexuses have no apparent connection, but they are really continuous. The apparent independence is due to the fact that they do not lie in the same plane. The same is true for the epicœle and metacœle; the section is made caudad of their point of junction.

d. The section also shows the kilos, the cestus, the floccular and paraflocular sulci, the paraflocculus and prepileum.

Fig. 39. Transection of the same specimen farther cephalad. The section is slightly oblique; the right side passes through the peduncle, the left is just caudad of it. It shows,

a. The epicœles and the parepicœles, at the left the connection between the two lateral U-bends.

b. The epiplexus.

c. The mesencephalon with its cavity, mesocœle ; sections farther cephalad show the junction of the epicœle with the metacœle.

d. The thin roof of cephalic part of the epicœle (valvula) and a part of the cephalic extension of the cerebellum, which later becomes the preramus.

e. The cephalo-lateral extensions of the cerebellum (prepileum) clothed with cinerea, while just mesad two rounded elevations appear, the cephalic bundles, or prepeduncles.

Figs. 40 and 41. Sagittal sections through the cerebellum of an embryo kitten 93 mm. long. Compare with Figs. 17 and 20, Pl. II. Shows a section through the U-bend including,

a. Supraflocculus } Constituents of the paraflocculus.
b. Mediflocculus }

c. Flocculus.

d. Kilos, plexus, tela, parepicœle and cestus.

e. Auditory region.

Fig. 41. A section a little farther mesad includes the tip of the prepileum.

PLATE IV.

Fig. 42. Mesal aspect of the cerebellum of an embryo kitten 45 mm. long. Shows the condition of the parts at this early stage. The ental surface of the cerebellum is now concave instead of convex. Compare Figs. 31, 35, 36, 37, Pl. III ; also Figs. 43, 44, Pl. IV. It certainly looks as though the cerebellum had rotated caudo-ventrad. This seems to me the simplest and most logical explanation of the change in the position of the ripa from that shown in Figs. 31, 34, 35, Pl. III, to the position shown in this figure. Note the relative thickness of the valvula and metatela, also the position of the plexus, and the floccular and uvular sulci.

Fig. 43. Mesal aspect of the cerebellum of an embryo kitten 55 mm. long. Shows essentially the same features as Fig. 42, and in addition the furcal sulcus which divides the cerebellum into two great divisions, the preramus and postramus. The former presents three sulci while the latter shows only one, the uvular sulcus. Contrast with Fig. 42, where the only one present is a very slight depression, the uvular sulcus. Note also the small volume of the cerebellum as compared with that of the oblongata in all stages up to this period.

Fig. 44. Mesal aspect of the cerebellum of an adult cat, No. 753 (x about 4). Shows the general structure of the mesal part of the cat's cerebellum which is quite like the condition found in man. The most striking feature, on first sight, in the arbor, whose tree-like branching is so characteristic of sagittal sections through the organ. It consists of a short thick trunk supported upon two lateral roots, or peduncles, and of two enormous branches, between which is the furcal sulcus. This sulcus forms a natural division and separates the cerebellum into two great regions. The cephalic is the preramus, the caudal is the postramus ; the latter forms the greater portion of the cerebellum.

As for the mesal part, or vermis, so much of it as is a part of the preramus is the prevermis, the remainder is the postvermis. In previous works all of the vermis cephalad of the peduncular sulcus has been called prevermis, but if we are to be governed by natural divisions, the prevermis ends at the furcal sulcus.

Each ramus is divided into smaller branches or lobes practically the same as in man where they have been given specific names. The same terms are applied to the regions which the writer considers homologous in the cat. It is interesting to note that apparently the pyramis is rudimentary in the cat, and that there is an additional lobe in the cephalic part of the prevermis. The writer suggests for it the term *cephalic lobe.* This subject will be further dis-

cussed in part II. It would have been desirable to show stages between those given in figures 43 and 44, but suitable material was not available.

Figs. 45, 46, 47. Sagittal sections of the cerebellum of a human embryo, No. 2862, about 10 cm. long; poorly preserved, but shows well the relation of the pileum to the paraflocculus, flocculus, and kilos.

Fig. 47. Shows the parafloccular sulcus, the floccular sulcus, and vermian tract.

Fig. 48. Section farther mesad than Figs. 45, 46, 47. It cuts the peduncle and shows the pontile and caudal bundles of fibers which stream up into the pileum; also the corrugations due to the developing sulci, the dentatum, the floccular sulcus, the kilos, the lateral U-bend enclosing the parepicœle, and its relation to the peduncle.

PLATE V.

Figs. 49, 50, 51. Brain of a human embryo 22 mm. long, No. 2652 (x about 6.7).

Fig. 49. Shows a slightly oblique view of the dorsal aspect, also the right side of the prosencephal foreshortened. Can hardly be understood without reference to Figs. 50 and 51. The mesencephal shows several curious transitory sulci which disappear later. The form and extent of the metatela are very apparent as is also the in-sinking collocated with the bend of the pons. This is indicated by the darker transverse shading and is marked *cst.* The cestus seems to be formed here. A part of the tela was destroyed in the dissection; this exposed the metepicœle and also shows the early parepicœle. Other features shown are,

a. The dorso-cephalic rotation of the cerebellum, better seen in Figs. 50 and 51.

b. Fhe relation of the tela to the kilos around its entire circumference.

c. The lateral U-bend.

Fig. 50. Right lateral aspect. Shows,

a. The position and extent of the isthmus.

b. The deckplate.

c. The fold in the metatela.

d. The cerebellum, the kilos, and ripa.

e. The lateral U-bend and parepicœle.

f. The bend of the pons.

g. The mesencephalic roof which is beginning to extend both cephalad and caudad.

h. The head bend and saddle cleft.

i. The bending ventrad of the kilos along the metacœle.

Fig. 51. Shows the same features and also the rotation of the cerebellum dorso-cephalad. Compare Figs. 1, 2, 3, Plate I.

Figs. 52 and 53. Human embryo, No. 3205, 41 mm. long, (x about 6.7). Shows the same features as Figs. 49, 50, 51, No. 2652, except the tela. The parts are larger, the caudal fold and lateral U-bend are better developed.

Fig. 54. Transection through the epencephal of a human embryo 39 mm. long, No. 2139, (x 6.7). Shows very clearly,

a. The thin deckplate not yet obliterated.

b. The cerebellum as two thickened masses forming the lateral parts of the roof.

c. The epicœle and its lateral extensions the parepicœles.

d. The kilos.

e. The tela and epiplexus.

f. The caudal fold.

g. The transverse furrow in the metacœlian floor caused by the bend of the pons.

Fig. 55. Mesal aspect of the epencephal of a human embryo, No. 2, 22 mm. long, (x about 6.7). Shows the cerebellum as a fusiform mass lying in the lateral part of the roof and twisted somewhat so as to conform with the general shape of the epencephal at this period of development. The other features need no further explanation.

Figs. 56 and 57. Cerebellum of a human embryo, No. 2926, 60 mm, long (x about 6.7).

Fig. 56. Dorsal aspect, shows a very interesting stage in the development of the cerebellum. It looks as though a ventro-caudal rotation from the position shown in Figs. 50, 51, 52, had taken place. Compare Figs. 31, 35, 36, 37, Pl. III, and Figs. 42, 43, Pl. IV. I have thus far failed to obtain specimens between 41 and 60 mm. in length. The examination of such specimens would probably show whether such rotation does or does not occur. The specimen also shows,

a. The caudal projection of the mesencephalic roof. It differs from the conditions seen in the cat where the mesencephal is notched or heart shaped; here the reverse is the case.

b. The floccular sulcus which begins in the lateral region.

c. The kilos, the tela, the cestus, and a mesal transitory sulcus in the mesencephalon.

Fig. 57. Shows the left lateral aspect and practically the same features as 56 ; also,

a. The peduncle of the cerebellum.

b. The pontile flexure.

c. The crus and the overlapping caudal margin of the cerebrum.

PLATE VI.

Figs. 58 and 59. Cerebellum of a human embryo, No. 3348, 80 mm. long (x about 6.7).

Fig. 58. Shows the dorsal aspect.

a. The mesal part is still depressed and thin ; no sulci have as yet appeared upon it.

b. The lateral parts, pilea (so-called lateral lobes), are large subspherical masses. Their increase in size from now on is quite rapid.

c. The paraflocculus sulci, one on each side, have appeared and the floccular sulcus now extends clear across the cerebellum.

d. The paraflocculus is more obvious than the flocculus; compare Figs. 10-14, Pl. I.

e. The tela, kilos, cestus, lateral U-bend, auditory region, caudal fold, etc., are quite obvious.

f. A part of the metatela has been removed to expose the metacœle.

g. The caudal extension of the mesencephal.

Fig. 59. Left lateral aspect of the same specimen.

Figs. 60 and 61. Human embryo, No. 3209, 90 mm. long (x 6.7).

Fig. 60. Shows the dorsal aspect. A few new sulci have made their appearance,

a. The furcal sulcus.

b. The uvular sulcus.

c. The nodular sulcus.

The tela and plexus have been removed; this exposes the cavities and other features which otherwise could not be clearly shown; viz:

1. The metacœle.
2. The epicœle and paracœles continuous with the metacœle.
3. The lateral U-bend.
4. The caudal fold.
5. The auditory region.
6. The mesal groove in the floor of the cavities.
7. The preramus; all of the organ caudad of the furcal sulcus constitutes the postramus.

Fig. 61. Shows the left lateral aspect of the same specimen and the beginning of a small sulcus, which appears to be the peduncular sulcus. It divides the pileum into two general regions, the prepileum the smaller of the two, and the postpileum, which forms the greater part of the so-called lateral lobes of the cerebellum.

Figs. 62 and 63. Cerebellum of a human embryo, male, No. 3347, 95 mm. long (x 6.7). The growth of the mesal part is gaining upon that of the two pilea. But there is a question whether or not the vermis is yet present. No new sulci have appeared upon the dorso-caudal aspect but the ones already there have a greater depth. The left parepicœle is represented as though a part of the tela had been removed (it was badly torn in the dissection) to show the structure of the plexus. It may properly be compared to a series of bunches of grapes suspended from a strap-like support, the cestus. The metapore was artificially enlarged during the dissection.

Fig. 63. Shows the left lateral aspect of the same specimen. A few (two are shown) new sulci have begun to form upon the cephalic aspect of the cerebellum. An opening into the parepicœle, the parepiplexus, and the torn edge of the tela, are also shown.

PLATE VII.

Fig. 64. Mesal aspect of the cerebellum of a male human embryo, No 2084 (x 6.7), age and history unknown. Shows the division by the furcal sulcus

into preramus and postramus; also the beginning of the regions found in a mesal aspect of the adult organ. Compare with Fig. 67, also fetal, although adult features exist. Note the relative difference in size of the preramus in the two figures 64 and 67. I am in doubt about the part marked lingula in Fig. 64. This subject will be discussed further in Part II.

Figs. 65, 66, 67. Cerebellum of a human embryo, No. 2279, size, age, and sex unknown (x 4). The specimen had been medisected and the left half partly dissected by a previous observer.

Fig. 65. The dorso-caudal aspect of the cerebellum is foliated, but less than in the adult. The following features are shown,

a. The form and divisions of tbe caudal three lobes of the postvermis and their relation to the pilea and floculus.

b. The enormous development of the pilea and the consequent covering up of the flocculus and paraflocculus.

c. No attempt has been made to describe the different lobes of the pilea since that subject and comparisons with other mammals can be more profitably discussed in part II.

d. The metepicœle ("fourth ventricle") and its relations to the parepicœle.

e. The relation of the parepicœle to the flocculus and kilos; the latter forms what is commonly known as the *postvelum*, *hinteres Marksegel*, *valvula semilunaris*, *etc.*

f. The relation of the plexus to the parepicœle.

g. The existence of the flocculus and paraflocculus as distinct regions of the cerebellum, demarcated by sulci. These features are concealed by the overhanging pileum upon the right side. The pileum has been dissected away from the left side. The fiber relations of the flocculus are very peculiar; a large bundle goes ventrad into the pons. These relations will be discussed in part II.

h. The continuity of the uvula with the tonsilla.

Fig. 66. Right lateral aspect. The left half had been previously dissected. Shows the division of the cerebellum into two unequal parts, the preramus the smaller and cephalic, and the postramus, the caudal part. The latter forms the chief mass of the organ. This is again divided by the peduncular sulcus into prepileum and postpileum; compare Fig. 67. The prepileum and preramus become furrowed earlier than the postpileum. Even in this specimen the sulci of the postpileum have not yet reached its lateral border. Compare Figs. 69 and 70, Pl. VIII. The figure also shows a lateral view of the paraflocculus, flocculus, the fifth and eighth nerves, the peduncle, and the pons.

The human paraflocculus becomes more or less foliated; indeed so far as my observations have gone it is quite variable; but I do not feel certain that there is the division into supraflocculus and mediflocculus, which is so general in the lower mammals.

Fig. 67. Mesal aspect. Shows the same features that are to be recognized in the adult organ, but in a condition to be more easily understood. The most obvious features are,

a. The tree-like appearance of the cut surface.

b. The approximately rectangular mass of alba which forms the trunk of the tree; its roots, *i.e.*, the peduncles, do not appear in a mesal section.

c. The two great branches, the preramus and postramus, which divide into smaller branches. Beginning with the preramus, from the lower part of the trunk, there arise,

1. The lingula.

2. In the cat and in most human cerebellums, a branch which is absent from this specimen, the cephalic lobe.

3. The central lobe forms a third branch.

4. The remainder of the preramus forms the culmen. Inspection shows this to contain four quite large branches. These four lobes constitute the prevermis.

The postramus contains six lobes ; viz.,

1. Arising from the caudal base of the trunk is the nodulus.
2. The uvula, divided into three smaller branches.
3. The pyramis, divided into two branches.
4. The tuber.
5. The cacumen, on the meson, a single twig-like branch.
6. The clivus, branched to form two twigs. The mesal parts of these form the postvermis. These lobes are separated by deep sulci, each one named from the lobe which lies next caudad of it.

d. The relative size of the pons and oblongata at the meson.

1. Prepontile recess.
2. Postpontile recess.

Fig. 68. Dorsal aspect of an embryo human cerebellum (x about 5.5). The figure has been drawn from two specimens, the cephalic part from No. 3161, human embryo, 15.5 cm. long, female; the caudal part from A. S27, human, male, 16.5 cm. long. Shows the general appearance of the developing sulci.

I am not yet ready to discuss the disposition of the sulci, but it is interesting to note,

a. That the two sides are unsymmetrical and that some of the sulci overlap *i.e.*, while most of the sulci seem to rise in the mesal region, one at least arises in the lateral region and extends mesad.

b. The right side of the cacumen is furrowed in a manner different from the left side; this will be further discussed in Part II. Compare Fig. 65, Pl. III and Figs. 59, 71, 72, 73, Pl. VIII.

The position of this figure upon the plate is undesirable but unavoidable.

PLATE VIII.

Figs. 69, 70. Cerebellum of a human embryo, No. 2947, male, 15 cm. long (x 6.7). The preramus and prepileum are foliated, but the postpileum on each side is smooth.

Fig. 69. Dorsal aspect. It shows,

a. General regions.

b. The mesal beginning of the vermian lobes and the sulci which demarcate them.

c. The postpileum upon each side is still smooth.

Fig. 70. Left lateral aspect. Shows the lateral aspect of the same features as Fig. 69 and,

a. The paraflocculus and its sulcus.

b. The flocculus and its sulcus.

c. The kilos and parepicœle.

d. The auditory region and eighth nerve.

e. The peduncle of the cerebellum.

Fig. 71. Caudal aspect of the cerebellum of a human embryo, No. 2947, male, 15 cm. long (x 6.7). The relation of the paraflocculus has been added from No. A. 827, human embryo, male, 16.5 cm. long. The caudal part of the left postpileum has been sliced off so as to show the relation of the flocculus and paraflocculus ; compare Fig. 65, Pl. VII. Shows the beginning of the general regions and structures to be found in the adult organ.

Figs. 72, 73, 74. The cerebellum of a child at term, No. 2961, female, (x 2.3).

Fig. 72. Dorsal aspect. Shows the division of the organ into lobes and folia. Compare with Figs. 68, 69, Pl. VII.

Fig. 73. Shows the caudal aspect. Compare with Figs. 65, 69, 71. Note, that the flocculus and paraflocculus are almost entirely concealed by the postpileum and parepiplexus.

Fig. 74. Shows the cephalic aspect. Compare with the preceeding figures. Note,

a. The flocculus.

b. The eighth nerve.

c. The peduncle.

d. The pons.

e. The prevermis (culmen, central lobe, cephalic lobe); the lingula does not appear.

f. The crura.

These three figures show the condition so characteristic of the adult organ, *i. e.*, the division into lobes by deep sulci and the subdivision of the lobes themselves into narrow folia by the shallower crevices or rimulæ.[1] The probable use of this profuse foliation is to give a greater amount of potential cinerea. The structure will be further discussed in part II.

Fig. 75. Caudal aspect of an adult human cerebellum. No. 3117, male, (x about 1).

---

1. The term rimula was proposed by Wilder, 36, 125.

Preparation.—The dorsal third of the organ was sliced off. The projecting parts of the postpilea were crowded dorso-cephalad and kept in this position till hardened by means of pledgets of absorbent cotton. Alcohol was the hardening agent employed. The result has been to disclose features which are not seen without special preparation. Points illustrated are,

a. The massive, hypertrophied pilea.

b. The pons and the peduncles of the cerebellum.

c. The caudal part of the postvermis, part of pyramis, uvula, nodulus, and vallecula.

d. The kilos, (*valvula semilunaris*, *postvelum*, *hinteres Marksegel.*)

e. The metatela and plexus.

f. The cestus.

g. The metapore.

h. The eighth nerve.

i. The oblongata.

j. The flocculus and paraflocculus.

NOTES ON CHILD EXPERIENCES.

By C. L. Herrick.

I.—Anthropomorphization of Numerals.

A phenomenon not unlike that of pseudochromæsthesia has recently come under our notice which may warrant a brief description. For lack of a better term we have used the self-explanatory, if portentious one that forms our heading, believing that the process described is but one of many indications of a tendency existing at a certain age in most children to predicate of inanimate things, and even the most unlikely phenomena, human characteristics and feelings. It would lead too far to enquire whether this undoubted tendency in the course of ontogeny is the condensed epitome of a similar state in the phylogeny of the human race, though analogy points strongly in that direction. The writer, though reared in almost absolute seclusion in a family as free as possible from any trace of superstition, can recall a period in early childhood when this tendency to anthropomorphization was very powerful and embraced nearly the whole range of his experience. Not only was he accustomed to lie literally on the bosom of the earth listening to fancied responses to his unexpressed emotions, but the various places frequented acquired each its peculiar feeling-value. The first bare sports in Spring had an intense emotional property and were themselves conscious of their approaching liberation. Stones with peculiar shape and color, and especially such as had holes in them, became charms and fetishes to which appeal was had in moments of perplexity or grief. I certainly had never heard of either charm or fetish and the notion seemed a spontaneous product of the mind. One would talk freely to these charms and would feel the utmost confidence in the sympathy, if not the active assistance, of the genii invoked.

Places at which a notable experience had occurred had ever after a peculiar power of sympathy ; in short, any and all inanimate objects and miscellaneous happenings acquired in my experience an emotional value and human-like character. These are, we doubt not, experiences common to all sensitive children, yet they should not be disregarded in the comparison of the racial with the individual development.

The special instance to be here recorded is that of a rather exceptionally sensitive boy of ten years who is advanced in his studies perhaps a year as compared with the average. There are no idiosincracies and the peculiar qualities attributed to numerals have, as he says, been instinctive from the first. In general, the odd numbers always impress him as possessed of unpleasant or "mean" attributes. He could assign no reason unless it was because they always made other numbers uneven when affecting them; at the same time, he is sure that he had the same ideas before he reached the subject of multiplication in arithmetic. The following is the list of numerals with the attached ideas :

No. 1. Mean, small figure with a sour face. The face is visualized, having a big mouth, little eyes, a frown and a pimple-like nose. He seems to be dressed in a pleated coat. There are some boys who look a little like this figure, but it is not associated with any one especially. He is dwarfish and "pigeon-toed" with bow-legs. The impression is of something insignificant and he does nothing but stand up straight and look at one. He is mean, perhaps, because he does not add to the value when multiplied by.

No. 2. A good little figure, trying to make things even.

No. 3. Mean; cheats other numbers and makes them uneven when multiplied. Has a face like No. 1.

No. 4. Good little number with a grin on his face. Always trying to help somebody.

No. 5. Little old man with an unpleasant face, sneaking up behind trying to injure someone.

No. 6. Just like No. 2, an invisible spirit trying to do good.

No. 7. Bad number, trying to be good but always failing. Is redeemed in part by the fact that when multiplied by 2, he becomes even.

No. 8. Like No. 2. Always liked.

No. 9. A soldier (this probably because the boy formerly amused himself by converting the figure into a skeleton soldier). The character was always supposed to be "mean."

No. 10. Big old man with a white beard and snowy locks. Of a benevolent disposition and always smiling.

No. 11. Jolly, happy-go-lucky individual, with an idiotic grin, equally ready to go on either side.

No. 12. Stern old fellow, always on the right side.

No. 13. Mean, like No. 1.

No. 50. Sneak.

No. 100. Like No. 10.

While there is no doubt that some of the coloring of the associated feelings has arisen from the difficulties of use in arithmetic and from the struggles with the tables, yet the evidence is good that these ideas date from an early period and are fairly constant. The same boy habitually regards a process in arithmetic as a battle in which the figures are engaged on opposite sides.

It may be added that the effect of the extreme tendency to predicate human attributes to objects and to introduce the anthropomorphic element into experience is apparently bad, tending to lead the child to shift responsibility and perhaps to become morbid and fatalistic. This tendency may persist long after the individual has ceased to have any real faith in the ideas. Solitary children are especially exposed to the evil and are likely to acquire the associated habit of talking to themseves which tends to perpetuate it. Improper religious teaching is also a prolific source of this evil, which, in its last extreme, is religious insanity, so-called.

II.—HALLUCINATIONS OF VISION IN CHILDREN.

It is probable that visual hallucinations are much more common among children than among adults. The plasticity of

the childish organism makes it especially subject to transitory but vivid excitement. The child will usually say nothing about these visions for fear of ridicule, as adults seem prone to turn the inner life of a child to sport and thus not rarely destroy the germs of the most priceless of faculties. Even if the child reports the hallucination it is regarded as simply an unusually vivid dream.

The difficulties in securing reliable evidence here are great indeed, but so they are with adults. Take the familiar attempt to discriminate between those who are and those who are not good visualizers: the answers come promptly enough, "I see the objects of recollection just as if they were before me, only the outlines are dim as if the objects were imperfectly lighted." Now we may be pretty confident that they do nothing of the sort. A few questions will convince us that the subject is incapable of discriminating between a mind picture and a visual projection. That such a power exists in exceptional cases is undeniable, but that it exists so commonly as recent tabulations seem to show we hold to be a patent fallacy. The writer has a very good visual memory and is very dependent upon it, in fact most of the mental processes are based on visual accompaniments, yet he was surprised to find, some time since, that the power of voluntary visual projection does not exist to any appreciable extent. When I recall a familiar object the first seeming is as if I had actually seen the objet through a haze, but more careful analysis shows that the mental picture is something entirely different from the visual picture. It will be found that these mind pictures are bundles of attributes, or rather the elementary states of feeling which habitually accompany the sight of the object in question.

In ordinary experience all of the commonly associated feelings appear in the reproduction giving to the product a spurious identity with the primary percept. Of course if absolutely all were so reproduced the absence of the actual visual image could not be detected, but the partial or imperfect return of these feelings gives to the product its hazy character. In dreams, on the other hand, the feelings reproduced are in ab-

normal groups and at once betray their non-visual character when judgement is allowed to act.

The hallucinations of childhood are quite distinctly visual and are located in or beyond the eyeballs. They are involuntary, though they may be caused to tarry a moment by close attention or may be dissipated by a sudden motion. During much of the writer's boyhood these hallucinations were a very frequent occurrence immediatly after retiring, and, even at a later time, they served to mitigate the slow torment of insomnia. In this case the pictures were quite generally landscapes in their natural colors and so vivid and charming as to give great pleasure.

These views rarely or never contained recognizable elements from actual experience nor could there be traced any association with real or imaginary places. Sometimes the images were of faces and the expression varied with kaleidoscopic frequency. Indeed there are many analogies with the transformations which are occasioned in one's cloud pictures by the changes in the forms of the clouds. The two phenomena have this in common also that there is in each case an objective occasion—a genuine sense irritation. In the case of the dream hallucinations this irritation seems to be furnished by the congested blood-currents in the retina or within the eye ball. The common belief that a pathological condition is necessary to the production of a great work of genius has this much of truth in it, that the minute subjective stimuli due to irritation of whatever kind, tend to form nuclei about which the fancy builds as it does with the cloud materials, though in either case there is the constructive imagination to be admitted as the prime factor in a work of art.

THE CEREBRAL FISSURES OF TWO PHILOSOPHERS, CHAUNCEY WRIGHT AND JAMES EDWARD OLIVER. [1]

By Burt G. Wilder.

These men were recognized as superior in character and mental power. They were mathematicians, and thought deeply upon the broadest questions. Wright was more of a writer and general critic; Oliver was more of a teacher of advanced mathematics. The latter was slight in frame and alert in action. The former was large in person and slow of speech and movement.

Wright's brain weighed 1516 grams (53.50 oz.), Oliver's 1416 (49.94). Although above the average of male brains (about 1400 = 49.4), greater weights are not uncommon, even among less intellectual persons. In both, the frontal region is unusually high and wide; the unprecedented squareness of Wright's suggests some *post-mortem* pressure, of which, however, there is no record. In both, the supertemporal fissure is larger than common. Oliver's fissures present several individual variations of the common type, but none comparable with the two rare conditions in Wright's already noted by Dwight (*Amer. Acad. Arts and Sciences, Proceedings*, XIII., 210-215, 1877) and the writer (*Jour. Nerv. and Mental Disease*, XVII., 753-754; *Amer. Neurol. Trans.*, 1890; "Ref. Handbook Med. Sciences," VIII., 158-159, IX., 108). The complete interruption of the central fissure has been observed in a dozen or more cases. The simplicity of the fissures, and the width and flatness of the gyres are paralleled in the Cornell collection only in the much smaller brain of an unknown mulatto (No. 322,

[1] Abstract of a paper presented to the American Neurological Association, June 7, 1895.

Ref. Handbook, VIII., Fig. 4767). Some approach to this condition occurs in Ruloff, a murderer (No. 965), and perhaps in a German shown by Wagner ("Vorstudien," Taf. VI., Fig. 2) after Huschke, ("Schädel, Hirn und Seele," Taf. V., Fig. 2).

If fissural simplicity and gyral width and flatness are family characteristics or correlated with Wright's mental and physical deliberateness, then light may be thrown upon the problem by the conditions to be observed in his blood-relations or in others similarly "slow but sure" in thought, speech and act. Since a close mate for the brain of Chauncey Wright has not been found in that of James Edward Oliver the contemplated full account of it need not longer await the death of other moral and intellectual compeers. Such exceptional cases will always command attention. But all estimates of the extent and significance of their peculiarities will be only provisional until the careful comparison of many *average* brains supplies one or more types or standards. This necessity should be kept in the public mind.

FORMALIN FOR THE PRESERVATION OF BRAINS.

(Preliminary Note.)

By PIERRE A. FISH, D. Sc.

Instructor in Neurology, Etc., Cornell University, Ithaca, N. Y.

In October 1893 I published* a method for preserving the brain, which had for its objects a minimum of distortion, rapidity of action and economy. It was known as the Zinc-Glycerine method. The zinc chloride was added in order to effect a differentiation between the alba and cinerea, and the glycerine to increase the specific gravity of the fluid so that the brain might be supported.

Experiments with formalin (40 per cent. formic aldehyde) show that practically as good results may be obtained at less cost when the following mixture is employed:

Water, . . .	2000 cc.
Formalin, 40 per cent.,	50 cc.
Sodium chloride, .	100 grams.
Zinc chloride, .	15 grams.

The specific gravity should be about 1.05. In practice the brain is left in this mixture for a week or ten days (a longer stay is not detrimental) and when practicable the cavities and blood vessels are injected with the same mixture in order to insure a more uniform hardening. The specimen may then be transferred to 1 per cent. formalin (water, 2000 cc., formalin, 50 cc.) and may remain in this solution indefinitely, if the jar be kept tightly covered; or if it is to become a museum specimen it

*Wilder Quarter Century Book,

Water, . . .	400 cc.
95 per cent. Alcohol, .	400 cc.
Glycerine, . .	250 cc.
Zinc chloride, .	20 grams.
Sodium chloride, .	20 grams.

may, after a week in the second solution, be removed to 50 per cent., 70 per cent. and 90-95 per cent. alcohol for final storage.

An objection to the use of the formalin solutions for museum purposes would be the large proportion of water present, which would freeze at low temperatures and cause injury to the specimen or jar containing it. Since formalin is readily miscible with alcohol, as well as water, enough of the former might be added to prevent the freezing, say equal parts of 95 per cent. alcohol and 1 per cent. formalin ; the exact proportions have not as yet been determined.

After an immersion of two weeks in the formalin solutions, a human brain lost only 6.8 per cent. of its weight ; but after an immersion in 50 per cent. alcohol for eight days and an immersion for an equal length of time in 70 per cent. alcohol, a total of sixteen days, it was found to have lost 22 per cent. of its first weight. A monkey brain after an immersion of eight days in the formalin mixture lost 5.4 per cent. of its weight ; continued immersion in the same fluid for eighteen days longer caused a loss of less than 2 per cent. A fox brain was immersed in a similar mixture for five days and lost 6.5 per cent. of its weight ; it was left in the same mixture eighteen days longer and lost 2.3 per cent. more of its weight. The brains were firm and in excellent condition for dissection.

The second, or 1 per cent. formalin solution redissolves any of the sodium chloride that may remain in the brain, which is an advantage if the specimen is to be treated with alcohol, as the latter does not dissolve the salt. The brain should not be put from the formalin solution immediately into the strong alcohol as the tissue will shrink very materially.

Brains hardened by the above mentioned methods do not dry readily ; even alcoholic brains after soaking for a time in the formalin solution do not dry quickly, which is a decided advantage for class-room work.

The preparation recently introduced under the name of Formalose I have not yet had an opportunity to experiment with.

The formalin hardened preparations are not so firm as those

that have been treated with alcohol; but they seem to possess a greater amount of toughness and elasticity.

NOTE.—The following points are added at the suggestion of Prof. Wilder: 1. The pia may be removed more conveniently before the brain is put into 95 per cent. alcohol. 2. When first placed in the 95 per cent. alcohol a hemicerebrum or half-brain should rest upon its mesal and approximately flat surface for at least two days; otherwise some lateral flexure will occur.

When the percentage of formalin is mentioned in this article it refers to the per cent. of formic aldehyde present.

THE PHYSIOLOGICAL CONDITION OF CONSCIOUSNESS.

By Dr. Paul Carus.

Professor C. L. Herrick has favored my article on "The Seat of Consciousness" with a reply, stating the main objections to my theory, which are in brief as follows: (1) He regards my definition of the words "feeling" and "intelligence" as unacceptable; (2) he maintains that upon a dynamic theory of consciousness (such as I suggest) there is no need of a special organ, and if a co-ordinating mechanism were needed, the *corpus striatum* could not perform the function; the anatomical appearance, he says, is misleading; there are various masses of fibres passing through it in various directions which give to it the spurious character of a co-ordinating centre, but in fact it is almost structureless; (3) he insists that "the unity discovered "by all psychologists in consciousness is not like any physio- "logical unity we know of. It has for its peculiarity that which "separates it *toto cœlo* from all physical processes in its intimate "and conditioning relation to our own existence. . . . "The *felt* unity of consciousness has no necessary relation to "any *observed* physiological unity and the selection of an organ "becomes a superfluity."

As to the first objection I would say that the term "feeling" in the sense which I use it, is a legitimate extension of the popular meaning of the word; it is almost commonly accepted by the most prominent physiologists and psychologists of Germany, and I dare say also of England. I cite Helmholtz, Hering, Meynert, Wundt, Bilroth.[1]

---

[1]I happen to have a passage before me in the posthumous essay of the last-mentioned on music in the *Deutsche Rundschau*, (Vol. XXI, No. 1, p. 98) in which he says: "Ein Sinneseindruck kann empfunden werden ohne dass er zum Bewusstsein kommt. Wenn man einen enthaupteten Frosch mit einer Pincette kneipt, so zuckt das Bein; wir nehmen deshalb an, das der Froschrumpf emfindet, sprechen ihm aber das Bewusstsein ab," etc.

Professor Ziehen is an exception ; he defines feeling as "a presentation to consciousness" and thus, on mere logical grounds, ridicules the idea of unconscious feelings. Aside from Ziehen and his class there is a fair agreement on the meaning of the word as "an element of consciousness" ; and Professor C. Mercier, in Hack Tuke's Dictionary of Psychological Medicine, speaks in the same sense of consciousness (see *sub voce* "Consciousness") as "a bundle of feelings." Professor Herrick defines feeling as "an affection or state of consciousness" which definition he regards as of "almost universal usage" ; but I submit that this definition implies a theory which Professor Herrick would scarcely sanction ; it implies that consciousness has an existence in itself and that feelings are its various states or affections. This seems actually to be Ziehen's idea, for if feelings are states of, or presentations to, consciousness and not parts or elements of consciousness, it would indeed be absurd to talk of unconscious or even subconscious feelings. Consciousness, however, is not a thing in itself; it is not a unity but a unification, or, as Wundt says, not an *Einheit*, but an *Einheitlichkeit*. Its elements can exist also in isolation ; and when they are no longer co-ordinated in a special way, consciousness ceases, while the elements of consciousness may continue to exist. There is no entire eradication of all sentiency if, as in sleep, consciousness is obliterated.

While I believe myself to be in agreement with the leading psychologists as regards the usage of the term "feeling," I confess that my usage of the term "intelligence" may be a departure from the traditional usage of the word. "Intelligence" is frequently used as a synonym of "consciousness" or "conscious knowledge" in the sense of "noting" or "minding," while to me its essential quality is the methodical interrelation which is, or can be, established between mental images. It is a fact that long chains of reasoning frequently take place unconsciously, yet are they performed for some definite purpose and may legitimately be called "intelligent" ; they conform to the rules of logic, and determine in an appropriate way conditions in our objective surroundings. Whether

or not my definition be acceptable need not concern us here, for we do not quarrel about words. Suffice it to say that it seemed to me desirable to state the difference between consciousness and intelligence or mentation, the former being the state of awareness in feeling, sentiency, or knowledge of self-existence, while the latter is the psychical equivalent of cerebration or the interaction of memory-images which may remain unconscious and often becomes conscious only in parts or in its results alone. Unconscious mentation is not a mere physiological process; it is also a psychical factor, for if it were psychically a nonentity how could it have any psychical effects? How could we, for instance, have a "summation of irritations" (*Summation der Reize?*) There is a rich subconscious psychical life and there are some subconscious feelings, thoughts, and sentiments which are never brought into the realm of consciousness, in other words, which remain utterly unconscious.

In reply to the second point, I grant the probability that no special organ of co-ordination may be needed for a dynamical theory of consciousness. The co-ordination of feelings, it is quite true, constitutes the fact of consciousness and their co-ordination may not be specialized in one and the same place. Here I have to say that I do not think that consciousness has its seat in any local centre which would remain conscious even though the rest of the organism were removed. The term "seat of consciousness" is apparently misleading, and I almost regret having used it. I feel inclined to avoid it henceforth. By "seat of consciousness" I understood merely that organ by which through some kind of mechanical arrangement the connections between the memory-images are established so as to produce by their interaction the condition of consciousness.

If we compare the sense-organs to the receiver, or ear piece, in the telephone, the wires to the nerves, and the muscles to the recipient or mouth piece at the other end, the seat of consciousness so-called must be looked for in the central office where the connexions are made. All similes have their drawbacks, and it is understood that this comparison is correct only as a rough analogy of the main process of transmission. There

are, however, some important differences: first, there is the clerk in the central office who attends to the connexions at the request of the person at the mouthpiece who announces a message for some one at the other end, while there is no such being in the soul of man; there is no ego-entity who manages the interconnexions among memory-images. Secondly, the person who speaks at the receiver is the willing agent, while the various numbers of the wires which at the central office are interconnected are as dead as door nails. In the soul the message received by the sense-organs comes from the surrounding world and need not be the voice of a sentient being. It may be a ray of light or the noise of rolling thunder, or the smell of a dangerous gas, or any kind of impression which need not represent the will of a purpose-pursuing creature. On the other hand the wires and numbered keys of the mind are all aglow with life; they are sentient memory pictures, mostly fused into composite images, thus representing generic concepts and if a call is made upon them through any one of the senses, they feel themselves appealed to, according to the nature of the call and their own nature, and the kinship that obtains between both and are always ready to start the action of the muscles attached to them. They are automata in the original sense of the word automaton; viz., they are "self-acting." Every one of them is attuned to a certain kind of irritations and responds automatically to its correspondent appeal. There is a third difference, and it is of importance, as here the difficulty of the physiological condition of consciousness appears. In the mind as well as in the telephone system, many intercommunications may take place at the same time. A person attends to a number of little and great things simultaneously in response to various sense-impressions, but one only rises into clear consciousness. Two men may be absorbed in an interesting discussion. But while their whole attention is concentrated upon the subject of their talk, they may walk together, they may respond to the recognition of passing friends, and avoid obstacles in the road. They may attend to hundreds of little things which remain unheeded, for unity is a law of our psychical or-

ganization and nothing but one idea, one purpose, or one action can at a time be illuminated by that state of mind which we call consciousness. The reason which we can find for it lies in the fact that consciousness is nothing but feeling in the focus of attention ; and attention is concentration or unification, which latter is imposed upon a mind by the need of a concerting co-operation of all the organs of an organism in pursuing a special purpose.

Now the question is, What is the physiological condition of this psychical unification of feelings? How is the convergence of attention attained?

I do not mean to enter into details, nor do I wish to repeat myself, but it seems to me certain that the hemispheres are constantly doing an enormous amount of cerebration which remains utterly unconscious. Hemispheric activity, accordingly, cannot *eo ipso* constitute consciousness. The problem is, What additional function raises the work of one hemispheric structure into the sphere of all-dominant attention ; and I believe that the *corpora striata* play an important role in the consummation of consciousness. They are ontogenetically a part of the hemispheres and are very early differentiated from the cortex. Their tissue is usually delicate and richer in capillary blood vessels than any other part of the brain. In addition to the fibres that pass through them, there are connexions with the hemispheres. The *corpora striata* possess terminal stations similar to those in the cortex, and from them the decussating pyramidal tracts of involuntary motions start, while the involuntary reflexes possess paths of their own directly descending from the thalamus. What is a voluntary motion if not a consciously willed reflex? To say, as Meynert does, on the basis of undisputed anatomical and physiological facts, that the *corpus striatum* is a ganglion of voluntary motion, implies that it is nothing but a deliberate preparation for action, i.e., voluntary motion.

In addition to these arguments, it is noteworthy that the development of the *corpora striata* is always proportionate to the cortical development. Meynert made the observation that

in mammals the powerful increase of the hemispheres is accompanied with a simultaneous and not less powerful increase of the *corpora striata,* while in all the lower creatures whose *psyche* is little developed the *corpora quadrigemina* and the *thalami optici* (the organs of instinct-reflexes, and involuntary motions) are of an extraordinary size and play the most important part in the nervous system. [1]

I do not say that the *corpora striata* are the seat of consciousness in the sense of being a localisation of the functions of awareness, but only indicate thereby that by their co-operation or super-added function the activity of some part of the hemispheres is so intensified as to become illuminated by consciousness. I know that I propose a theory which is not proved, but I submit it to further inquiry and shall not be ashamed to give it up when confronted with facts that disprove it.

I owe to Dr. Adolf Meyer of Kankakee a bibliography of the subject, which with his permission I insert here, as it may prove useful to those who wish to inform themselves on the function of the *corpora striata.*

---

[1] This sentence is an almost literal reiteration of Exner's *resumé* of Meynert's view which appears in his *Physiologischen Erklärung der psychischen Erscheinungen*, 1894, p. 26. He says:

" Wir dürfen vermuthen dass die genannten Ganglien der anatomische Ausdruck jener physiologischen Erscheinungen (der Willkürbewegungen) sind," etc. As to the connexions of the cortex with the great "*Stammganglien*" Exner says in the same booklet, p. 341 " für Linsenkern und Schweifkern wurde das bezweifelt, aber in neuerer Zeit wieder bestätigt." I need scarcely add that Exner still shares the traditional opinion that consciousness has its seat in the cortex. Prof. J. Dejerine, in his beautiful work *Anatomie des Centres Nerveux*, 1895, Vol. I, pp. 110-118, and 360-376, also mentions connexions of the corpus striatum with both the cortex and lower regions of the nervous system. Edinger, too, proves for certain that there are connexions at least between the striate body and the thalamus. Meynert's proposition has been conjectural, but, says Edinger, he has upon the whole been right in his divinations. Edinger's *resumé* is stated as follows :

" Linsenkernschlinge und Caudatusfaserung entsprechen dem basalen Vorderhirnbündel der niederen Vertebraten." See *Verhandlungen der Anatomischen Gesellschaft.* Eighth Meeting, Strassburg i. E, 1894.

BAGINSKY, A. and C. LEHMANN. *Zur Function des Corpus striatum* (*nucleus caudatus*) *; experimentelle Studien.* Virch. Arch. 106, 258-281.

Adult rabbits and young cats. (Suction method.)

1. Removal of cortex; lessened tension of extremities involved; general excitement. Recovery.
2. Cortex and marrow, same symptoms. During suction movements of mastication, head turned to side of operation. No special symptoms when ventricle was opened.
3. Irritation of uncovered corp. striata, rapid increase of temperature lasting 41.6°. No imperative running.
4. Destruction of nuclei caudati, excessive excitement without *Lauftrieb.* Rapid rise of temperature. Complete recovery. Loss of muscular sense increases with depth of operation.

BIANCHI and D'ABUNDE. Die in's Gehirn und Rückenmark herabsteigenden exp. deg. als Beitrag zur Lehre der cerebralen Lähmungen. N. Cbl. 1886. 385, Jan.

B. BRAMWELL. Case of cancer of the right lobe of the cerebellum and left lenticular nucleus; marked vertigo; no paralysis. Brain, 1888.

BUMM. Ueber ein bisher noch selten beobachtetes Markbündel an der Basis des Menschl. Gehirns. Arch. f. Psych. XIII. 1882.

DALTON, I. C. On the form and topographical relations of the corpus striatum. Brain, Vol. IV, 1880.

DEJERINE. Sur un cas d'hémianésthésie de la sensibilité générale, observé chez un hémiplegique et relevant d'une atrophie du faisceau rubané de Reil. Arch. de Phys. n. et path., 1890. Lesion of lenticular nucleus.

EDINGER, L. Zur Kenntniss des Faserverlaufs im Corpus striatum. Neur. Cbl. 1884.

EDINGER, L. Uber die Bedeutung des Corpus striatum. N. Cbl. 1887, p. 334. Das basale Vorderhirnbündel und das Corpus striatum in niederan Wirbelthieren. Spät markhaltig (nicht markhaltig in Larven die schon ganz selbständig leben, und demnach Bewusstsein haben dürften). Eine basale Opticuswurzel in der Gegend des Corpus mammillare.

EDINGER. On the importance of the corpus striatum. J. of nervous and mental Dis. XIV, 1887.

W. HALE WHITE. Report on the influence on the bodily temperature of lesions of the corpus striatum and optic thalamus. Brit. Med. J. 1889, p. 1401. In rabbits. Cp. Horsely on opt. thal.

HEBOLD. Welche Erscheinungen machen Herderkrankungen im Putamen des Linsenkeunes. Arch. f. Psych. XXIII.

64. Tremor of right extremities, later also of left, following an attack of dizziness. Senile dementia. Brain, 1120. Hydrocephalus, Hydromyelia. Small foci of softening in right putamen.

72. Tremor of hands and legs; anterior sclerosis. Haemorrh. softening in both lenticular nuclei.

73. Senile melancholia, small apoplectic cyst of left lenticular nucleus. No symptom.

70. Chronic halluc. paranoia—pea sized cyst in left putamen, larger than in the other cases—no symptoms.

E. A. HOMEN. Eine eigenthümlische Familienkrankheit, unter der Form einer progressiven Dementia mit besonderan anat. Befunde. N. Cbl. 1890. p. 514. Begun at the age of 20, 21, and 12; duration 6-7 years. Dizziness, heaviness, and pain in head; prog. dementia. Contratures, etc. Cp. Arch. f. Psych. 1892. Atrophy of cortex and softening of lent. nucleui. Atrophy of liver.

HUTCHINSON. A case in which paralysis of the sphincters and incontinence of urine were together with torpid intellect, the chief symptoms of symmetrical disease of the corpora striata. Brain, 1887, July.

JOURNIAC. Hémorrhagie du noyau lenticulaire. Ann. méd.-psych. 1891. Mai-juin.

70. Slight melancholia 10 years ago. Melancholia with imperative ideas for several months. No symptoms of motility or sensibility; pupils very narrow.

P. M. Rather fresh haemorrhagic focus of size and form of an almond, occupying the two ext. portions of nucleus lenticularis. Int. capsule free. No symptoms. Relation to melancholia or rather to imperative ideas insisted upon.

KATSCHANOWSKY. Ueber die oculo pupillären Certren. Med. Jahrb. k.k. Ges. Wien. 1885, N. Cbl. 1886. 53.

KOWALEWSKY. Das Verhältnis des Linsenkerns zur Rinde. Sitz. d. Wien. Acad. 86 Bd. 1882.

MARCHI. Sulla fina anatomia dei corpi striati e dei Talami ottici. Riv. sperim. di Fren. 1886.

MEYNERT. N. Cbl. 1896. p. 456. Naturf. Vers. Berlin. Legt. besonderes Gewicht auf die Einstrahlung der äusseren Kapsel in den Linsenkern, und auf die Verfolgung des Tr. opt. in den Thal. opt. Nahe Beziehung des Thal. opt. zu den centripetalen Bahnen. Legt Verwahrung ein gegen die Auffassung des äusseren Abschnittes des Linsenkernes als einer der Rinde gleichwertigen Hirnpartie. Epilepsie nicht cortical.

STEPHEN. Les tremblements prae-posthémiplégiques. Rev. de Med. 1887, p. 204. Always accompanied by lesions of pulvinar and post. part of post capsule or one of these points.

ZUCKERKANDL. Riechcentrum. Corpus striatum motorisches ganglion. Mandelkern hat nichts mit Riechcentrum zu tun.[1]

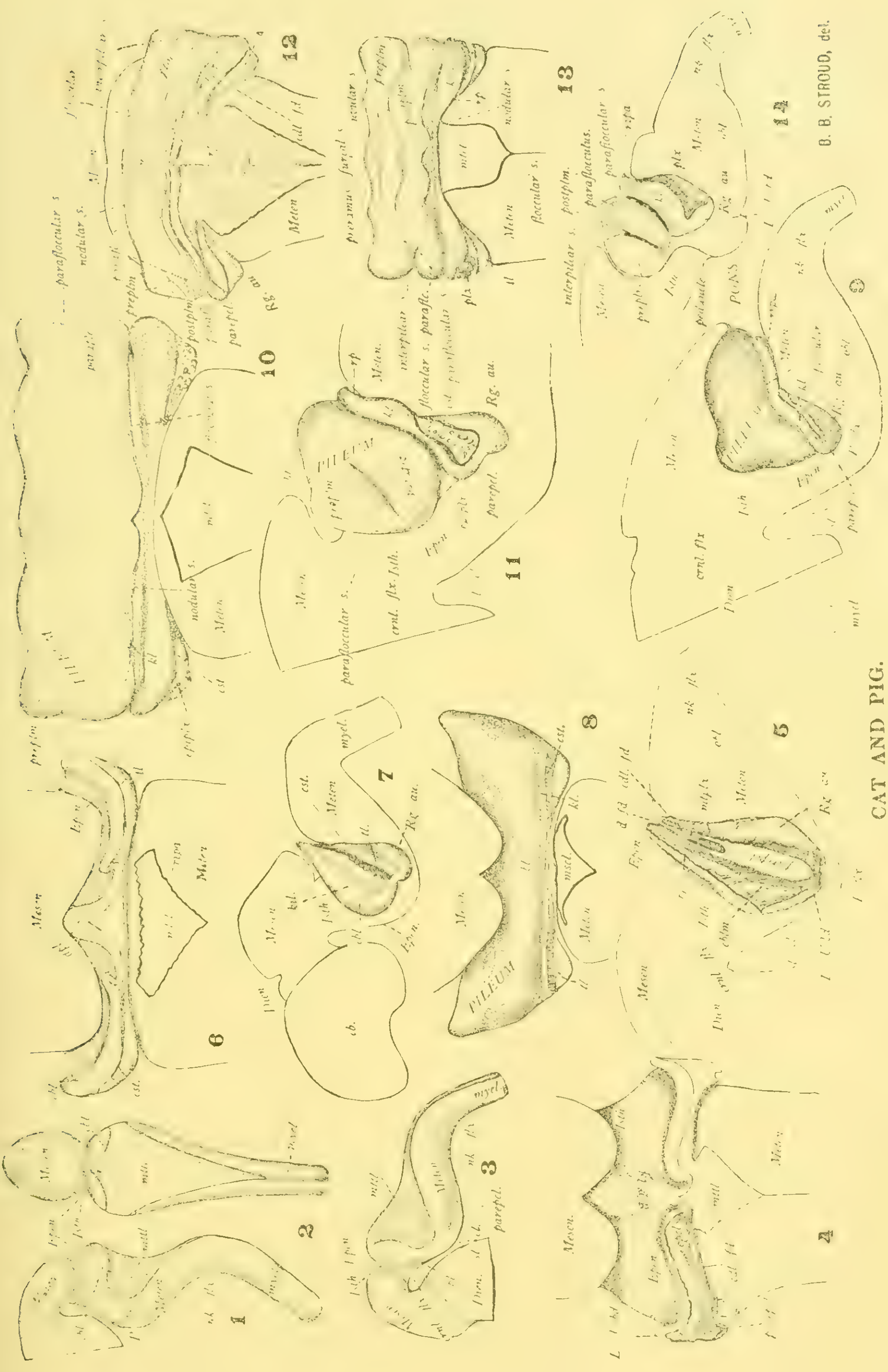
In addition to the literature on the subject, Dr. Meyer informs me that he had of late an interesting post mortem of an old epileptic dement, with extensive destruction of the centrum semi ovale and lenticular nucleus, the secondary degenerations being exceedingly extensive, and, be it incidentally mentioned, adding new information to our knowledge of the brain.

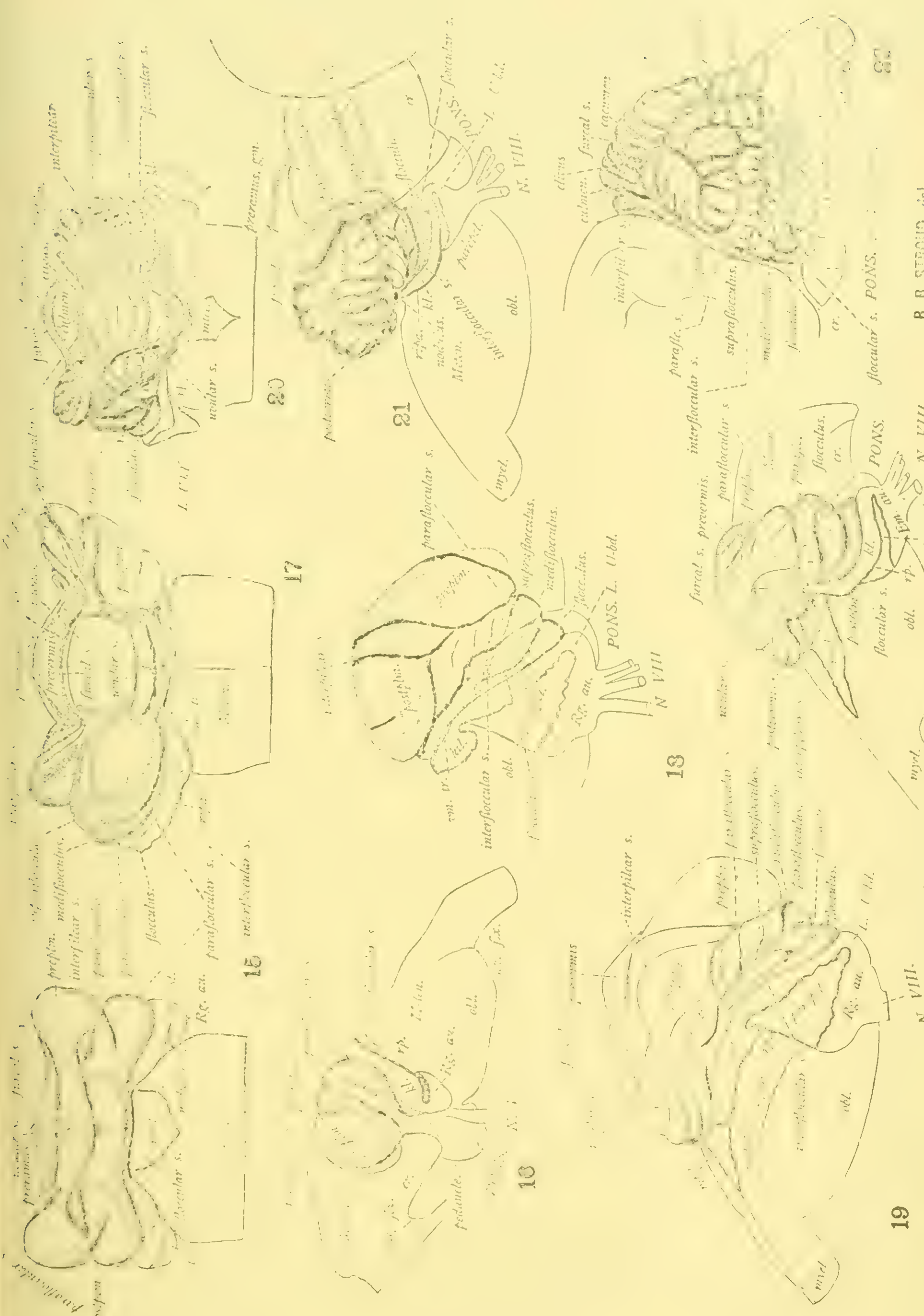
Dr. Meyer does not agree with my theory of consciousness; nevertheless the facts which he kindly furnished me are, to say the least, not unfavorable to my view. The diseases of the various regions of the *corpus striatum* are attended with vertigo, dementia, paranoia, torpidity of intellect, or melancholia—all of which may be disturbances of the function of co-ordinating and focusing the various elements of consciousness.

As to the third point, I may not understand Prof. Herrick's objection, but even in case there should be no organ of co-ordination in the brain, there ought to be physiological conditions on the presence of which the appearance of consciousness depends; and the problem of the nature of the conditions is not "removed from the field of possible investigation." The "*felt* unity of feelings" which we call consciousness, must have a definite relation to some physiological state, and it must be possible to describe the mechanism of the physiological operations required to bring about that attitude of an organism, the psychical equivalent of which is consciousness. Consciousness is undoubtedly the result of a co-operation of all parts of the organism. If a man concentrates his attention upon the sense of a sentence which he reads, the retina of his eyes, the centre of vision in the occipital lobe, the centre of language in the left hemisphere, the oculomotor nucleus in the brain stem, the voluntary centres of the corpora striata which

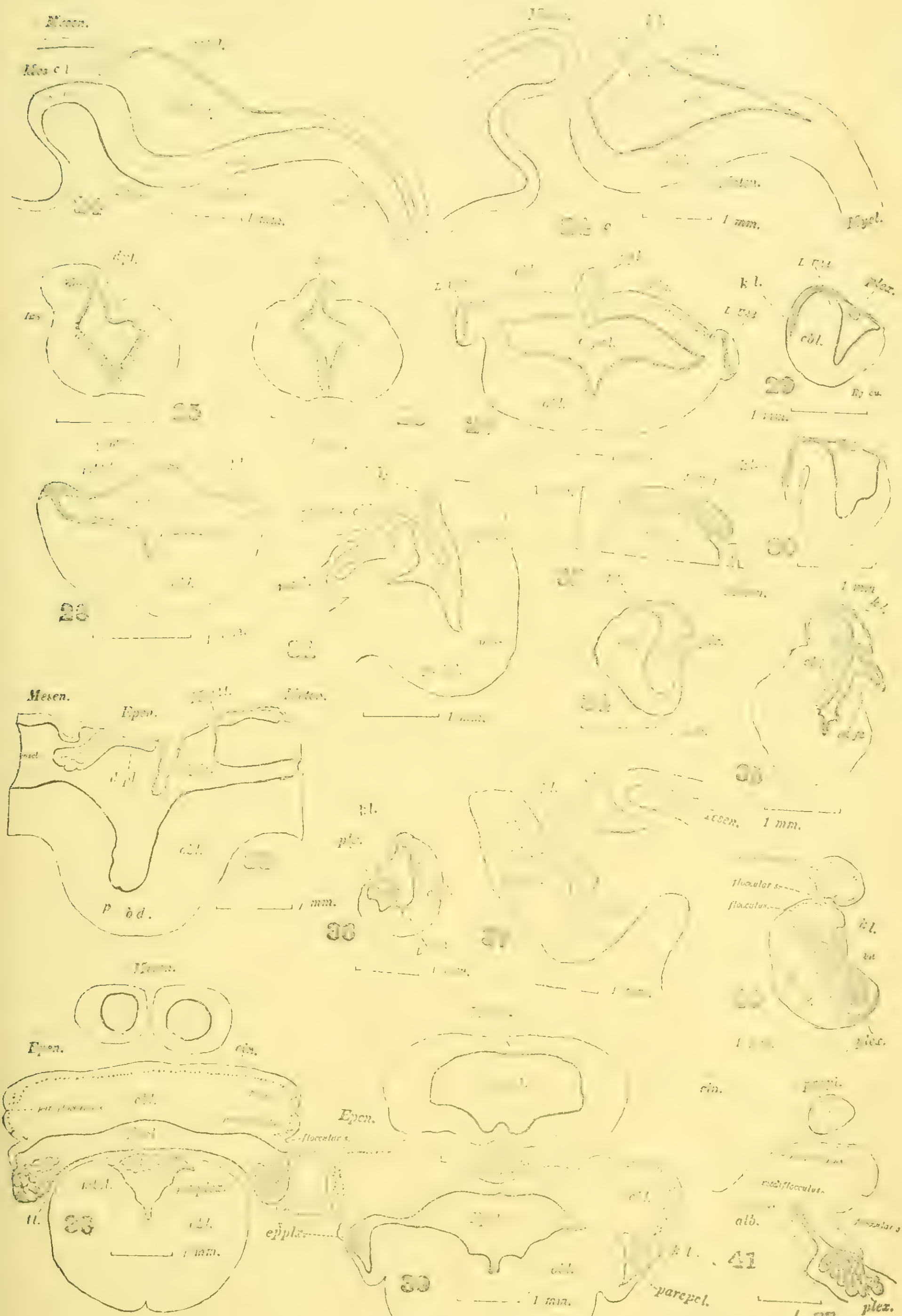
[1] Dr. A. Meyer should have included in this list his own investigations "Ueber das Vorderhirn einiger Reptilien," *Zeitschr. für wiss. Zoologie*, 1892, Leipzig, Engelmann; and "Zur Homologie der Fornixcommissur und des Septum lucidum bei den Reptilien und Säugern. *Anat. Anz.*, X, 15. Fischer, Jena.

adjust the motions of the hands, the involuntary centres in the thalami, are all engaged in the process and none of them can be dispensed with. As the most central of them we regard the voluntary progress of directive impulses, which to an unsophisticated self-observation appear as the deliberate decision of a free will upon which the motions of the lower centres depend. They represent the focus of consciousness and the few facts that are well ascertained suggest the idea that the *corpora striata* are the organ of this voluntary directive activity.


CAT AND PIG.
B. B. STROUD, del.


CAT.
B. B. STROUD, del.
15
16
17
18
19
20
21
22
23
N. VIII.
PONS.
flocculus.
paraflocculus.
obl.
myel.

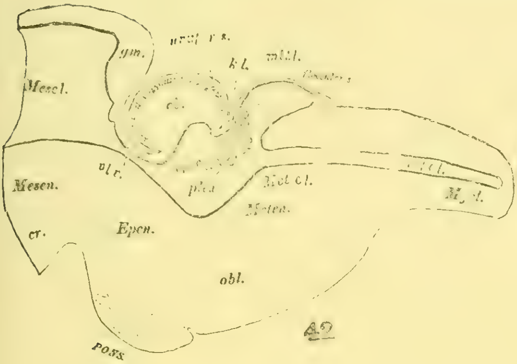
Journal of Comparative Neurology. Vol. V. PLATE III.



CAT AND PIG.

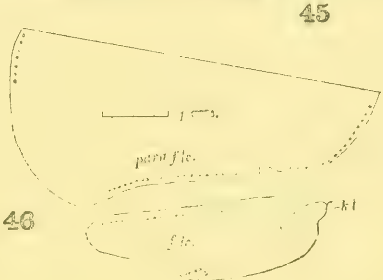
B. B. Stroud, del.

CAT AND HUMAN.

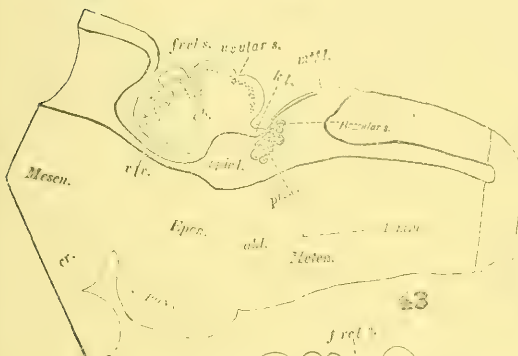


42

45



46



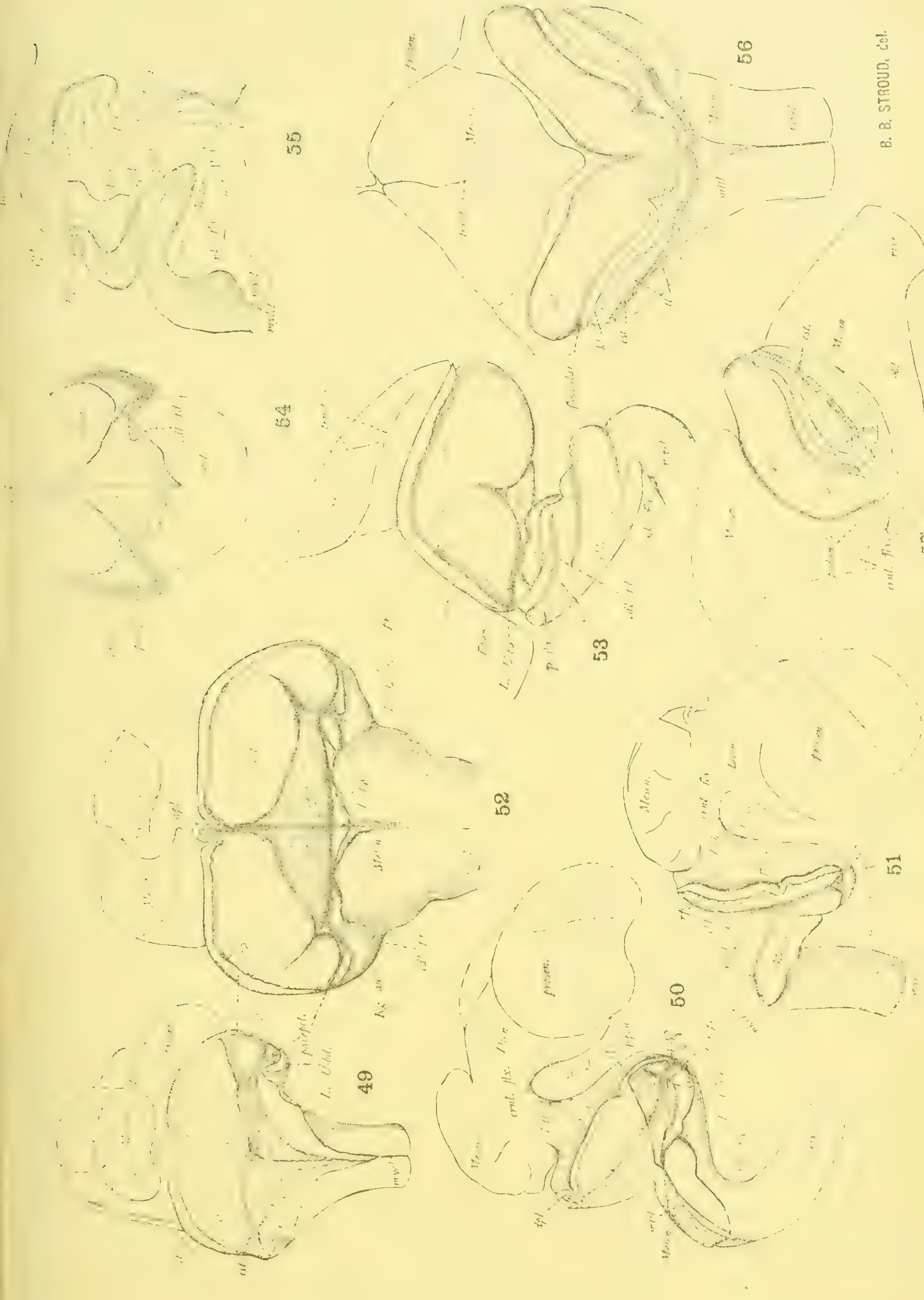
43

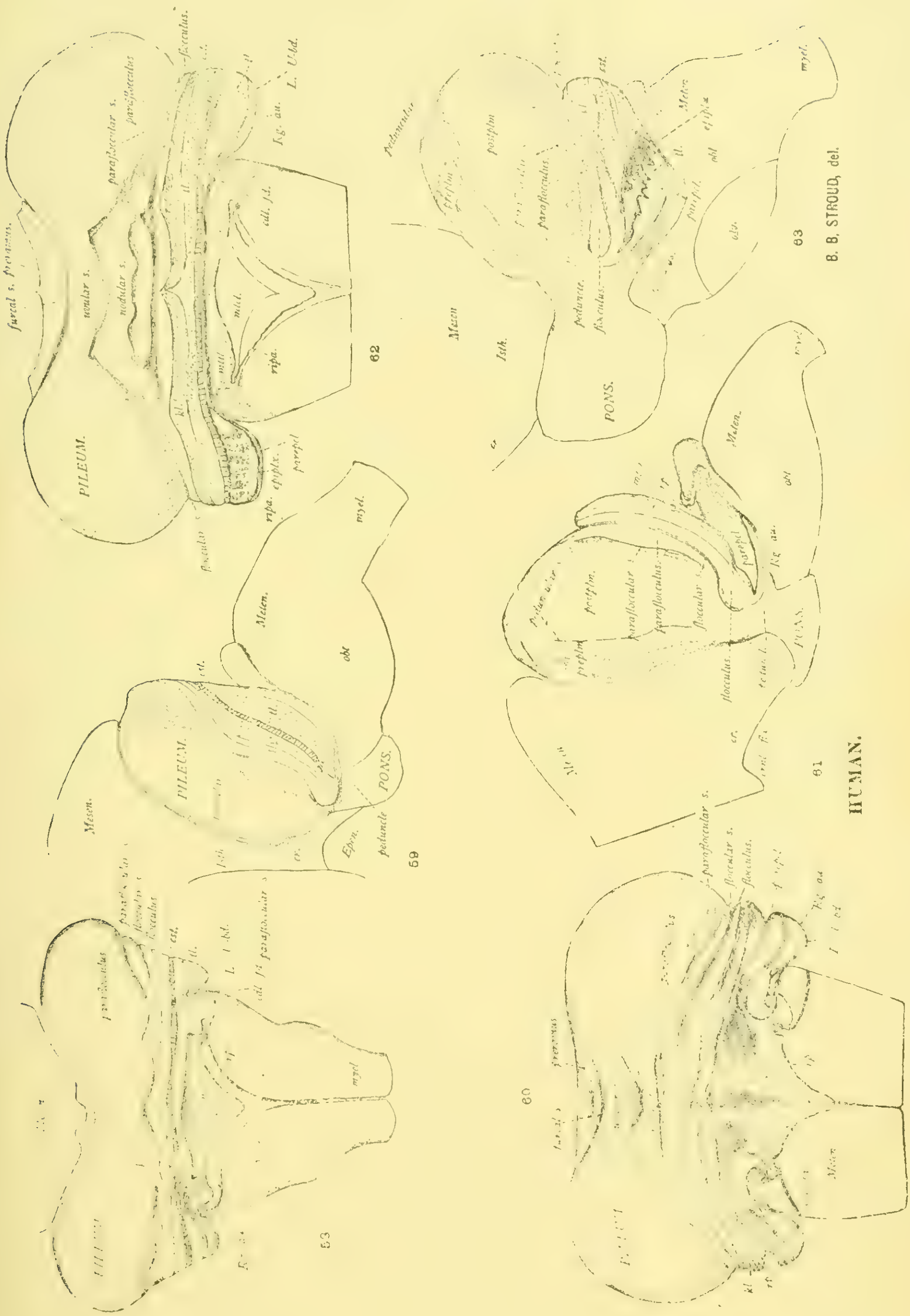
47

48

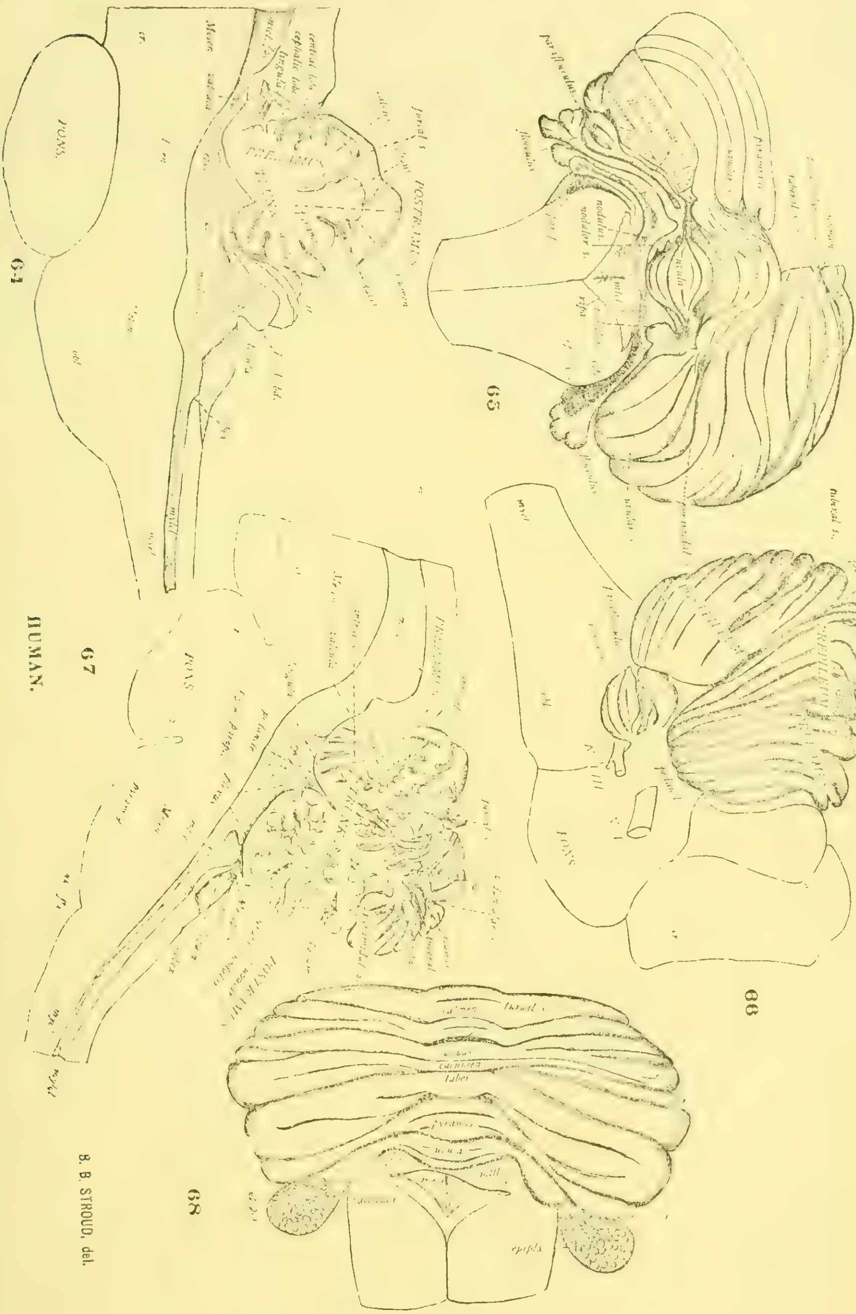
B. B. Stroud, del.

44


49
50
51
52
53
54
55
56
57
HUMAN.
B. B. STROUD, del.



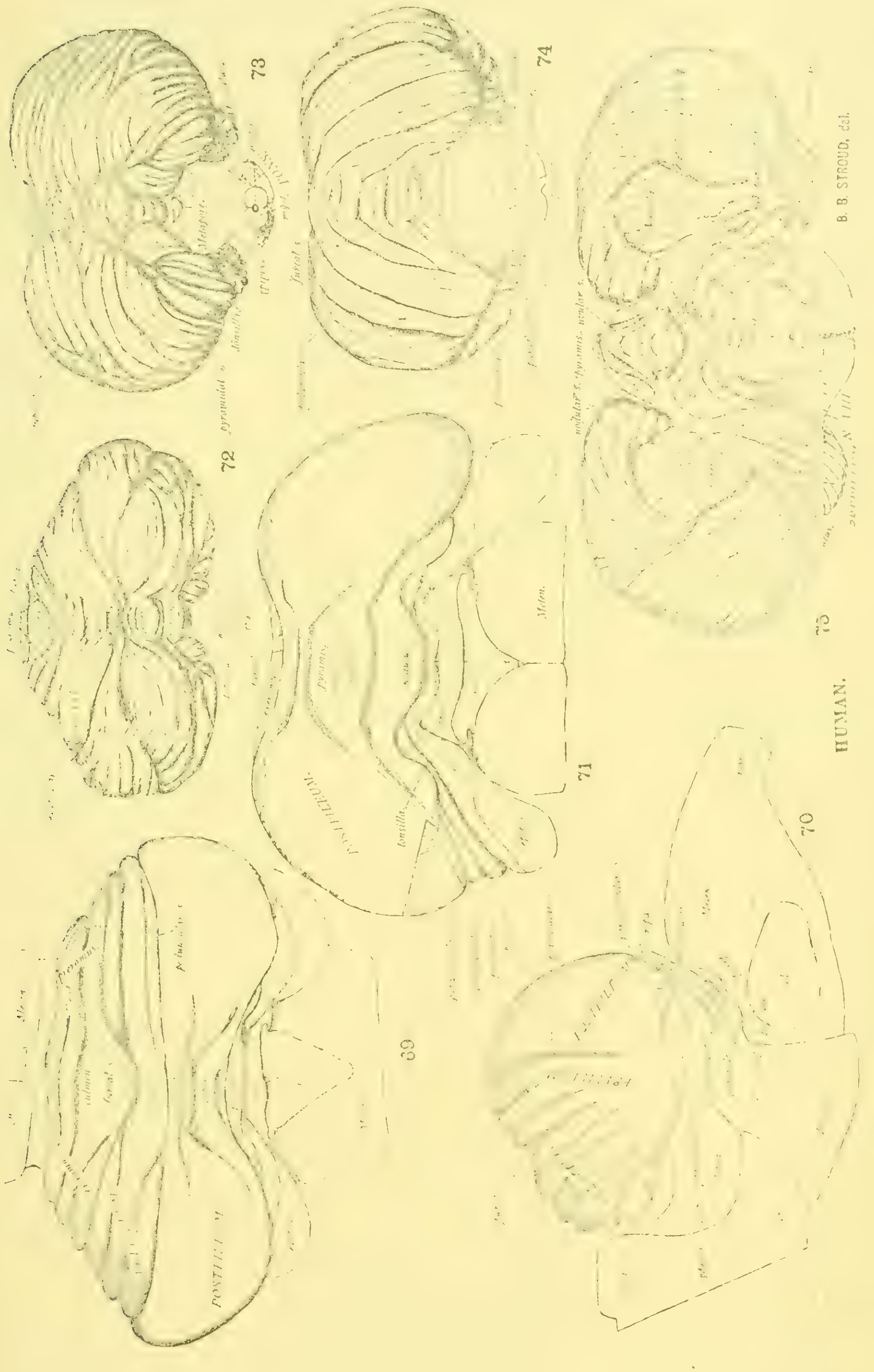
PILEUM.
PONS.
Mesen.
Meten.
myel.
obl
nodular s.
parafloccular s.
paraflocculus
flocculus.
ripa.
postplm
preplm
peduncle
Isth.
53
59
60
61
62
63
HUMAN.
B. B. STROUD, del.



64 65 66 67 68

HUMAN.

B. B. STROUD, del.



69
70
71
72
73
74
75
HUMAN.
B. B. STROUD, del.
Metapore.
PONS
Meton.
tonsilla
pyramis

ON THE BRAIN OF NECTURUS MACULATUS.

By B. F. Kingsbury. Ph.D.

Fellow in Vertebrate Zoology, Cornell University.

(*With Plates IX, X, and XI.*)

CONTENTS.

Introduction.

Morphology.

Histology.

INTRODUCTION.

This investigation was made in the anatomical laboratory of Cornell University. I am glad to acknowledge my indebtedness to the Anatomical Department for the material and facilities placed at my disposal: To the members of the Department, and particularly to Prof. Wilder and Dr. Fish under whose immediate supervision the work was done, I wish to express my appreciation of their interest manifested in it; the former put into my hands all his unpublished notes and drawings as well as numerous preparations of the brain made in 1873 and 1874. To Prof. Gage I am under deep obligation for material kindly obtained for me from Prof. Whitman of Chicago University and for suggestions as to methods. The series of sections through the brains of *Diemyctylus* and *Desmognathus*, which I have been enabled to examine by the kindness of Mrs. Gage and Dr. Fish have also been of great service to me. Numerous valuable suggestions have been gained from the discussions of the Neurological Conferences.

It is somewhat surprising that, although extended investigations have been made upon the nervous system of various urodeles by numerous anatomists, neither the brain of *Necturus*, nor, indeed, that of its European relative, *Proteus*, have received more than a very fragmentary treatment. The importance of these forms is obvious and has been recognized in the attention given to other parts of their structure. They are the lowest Amphibia, generally so regarded, and their perennibranchiate condition suggests at least the presence and persistence of what in other forms are larval peculiarities merely. Further, Necturus presents in its availability and the convenient size of its brain,—neither too large for convenient microscopic examination nor too small for macroscopic observation,—characters making it also well suited for the elucidation of the numerous problems connected with the amphibian, and particularly the urodele, brain. Therefore a somewhat complete treatment of this form would seem desirable.

Necturus is known to the literature of Neurology through the publications of Spitzka, Wilder, Osborn, Herrick and Fish, the attention it has received being largely confined to the interesting question of the presence of a callosum in Amphibia. So far as is known to the writer, Wilder ('84, 1) was the first to publish figures of any detail of the brain of *Necturus*.[1] Because of its simplicity it was employed by him in a lecture delivered before the Alumni Association of the College of Physicians and Surgeons, New York, February 4th, 1884, to illustrate the relations of the cavities and segments of the brain. It was one of the forms discussed by Osborn ('86) in his memorable papers on the "Origin of the Corpus Callosum"; in his subsequent article, "A Contribution to the internal Structure of the Amphibian Brain" ('88) the structure of the brain is discussed in conjunction with that of *Cryptobranchus*. Herrick's contributions to the structure of the brain of *Necturus* occur in the valuable papers by him in this journal, on the comparative morphology of the central nervous system. The mention by Fish ('95) of the relations of certain commissures in *Necturus* is merely incidental and is in connection with the question of the presence of a callosum in Amphibia. The views of these neurologists will be frequently referred to in the text.

MATERIAL AND METHODS.

The material employed in this investigation consisted chiefly of numerous brains of adult *Necturi* from 20 to 38 centimeters long. Cayuga Lake abounds in this form and fresh examples were available whenever needed. In addition to the adult, I have been enabled to examine a series of six larval *Necturi*, reared from the egg by Dr. Whitman of Chicago University. They were of the following ages and dimensions, viz.,—just hatched, 4 weeks, 6-8 weeks, 3½ months, 6½ months, and 10 months, with 22.5, 30., 28., 46.5, and 49.5

[1]Small and diagrammatic figures of the brain of *Necturus* had been previously published by Owen (Trans. Linnean Soc., XVIII, pl. 27, fig. 6, 1839.) and by Wyman ('52) in 1852.

millimeters for their respective lengths. This series was supplemented by a yet unhatched but well-developed specimen kindly furnished by the anatomical department. The entire heads of these were sectioned serially in three planes, sagittal, frontal and transverse, and were extremely valuable for comparison with the adult. In addition to *Necturus*, the brain of *Diemyctylus viridescens*, *Amblystoma punctatam*, and *Desmognathus fusca* were examined, especially for the oblongata and the origin of the cranial nerves, in order to confirm and better interpret the results obtained in *Necturus*. For the relations of the brain and nerves to the skull, and of the nerves to each other, serial sections were made through the entire cranium; for the study of the form and structure of the brain itself, however, it was removed.

For fixing, were employed mercuric chloride and a mixture devised by Dr. Fish ('93) and termed picro-aceto-sublimate (Formula: 50 per cent. alcohol, 1000 c. c., glacial acetic acid 10 c. c., mercuric chloride 5 grams, picric acid 1 gram.) The latter gave the best results. The stains employed with brains fixed as above, were hematoxylin with Van Gieson's picro-fuchsin as a contrast stain which gave excellent effects. The hematoxylins employed were Gage's ('92), Delafield's and Herrick's modification of Delafield's formula; all gave good results with possibly better figures when the last was used. Fish's modification of Delafield's also was employed with good success (addition of 1 c. c. of glacial acetic acid and 1 c. c. of a saturated aqueous solution of corrosive sublimate to 100 c. c. of the hematoxylin). For the fiber tracts were employed Weigert's hematoxylin method, and also one which is essentially a modification of Exner's perosmic acid method (Obersteiner) the osmium being used in conjunction with platinum chloride and acetic acid as in Hermann's solution. The stronger formula of this was used and the brain fixed for 24 hours, washed well in water for 4-5 hours and imbedded in collodion as usual, cleared and cut in Fish's castor-thyme oil mixture. It was found that the method could be employed also when decalcification was necessary, and that the blackness

of the nerve fibers rendered the course, relation and division of the nerves easy to determine. It is not thought, however, that this method would be applicable to larger brains, on account of the expensiveness of the fluid and its low power of penetration and the brittleness of the tissue induced. It was most useful in the study of the oblongata and the origin of the cranial nerves, where the results appeared more satisfactory than those gained by the Weigert method; the caliber of the fibrers and their relations were shown with the utmost distinctness. Tissue cut in collodion by Fish's oil method ('93) could be mounted without further treatment, or a delicate nuclear stain obtained by the use of safranin. Babes' first solution was employed (Formula: concentrated alcoholic solution, 50 c. c., concentrated aqueous solution 50 c. c.). The staining required two or three minutes, and 95 per cent. alcohol was used for washing out; (Lee, '93.) The shorter silver nitrate method of Golgi was employed in the study of amyelinic fiber tracts and of cells, though the unavailabity of larval material rendered the results less satisfactory than they otherwise would have been. The usual formulas for the solutions were employed and both double and single impregnations applied.

ECTAL FEATURES.

The dorsal aspect of the brain of *Necturus* has already been well shown by Osborn and Wilder. Its extreme length is very striking and the impression of a stretching betwen the myel and the olfactory capsules is strong. The pons flexure, which is present in *Triton*, and *Diemyctylus* and is marked in *Desmognathus* is very slight in the adult *Necturus*. The cranium also is not nearly filled by the brain, and the olfactory nerves are long nearly equalling in length the combined prosencephal and rhinencephal. In the larval *Necturus* however, the cranium is quite filled by the brain and there is a decided pons flexure, as well as a weaker neck flexure. The adult condition probably indicates that the growth of the brain and skull have proceeded at quite different rates, and that this difference is much greater

in *Necturus* than in the smaller urodeles[1] above mentioned.

The greatest widths are at the olfactory lobes and at the caudal extremities of the cerebrum, at which points they are approximately the same, and much greater than in the parts farther caudad. The height (dorso-ventral diameter) does not vary greatly in the different regions ; it is least in the region of the oblongata and greatest through the infundibulum where the height exceeds the width.

On the dorsum, between the caudal portions of the cerebrum, is the supraplexus enclosing the paraphysis. Caudad of this and likewise between the caudal ends of the cerebrum, is the diatela, bounded caudally by the habenas and at the meson by the supracommissure. The epiphysis is almost circular in outline, lying dorsad of the supracommissure and extending caudad to the postcommissure and also slightly cephalad. There is no ectal distinction on the dorsum between the diencephal and mesencephal save possibly a slight transverse furrow at the postcommissure.

Pigment is generally present on the mesencephal and absent from the diencephal, but this distinction is not constant, the diencephal often being as highly pigmented as the mesencephal.

On the ventral surface is conspicuous the large hypophysis attached to the caudal portion of the infundibulum. The optic nerves are very small and the chiasma is not superficially noticeable. Cephalad of this is a subtriangular space bounded by a whitish area marking the region of the preoptic and lateral optic recesses. The metencephal is simple and very long ; indeed, it equals in length the entire remainder of the brain. It tapers gradually from its widest point at the exit of the fifth nerve to the myel.

The cerebellum is represented only by a small transverse

[1] The restriction of Urodela and urodele by Cope to a single order of tailed Amphibia is unfortunate; it leaves no convenient term that can be applied to all the tailed Amphibia in contrast to the Anura or tailless forms,—a convenient grouping, although perhaps not of taxonomic value. *Urodele* is used here as synonymous with "tailed amphibia."

band of fibers caudad of the mesencephal. Directly caudad of this is the membranous roof of the metencephal, the metatela, a portion of which is occupied by the metaplexus which sends lateral projections cephalo-laterad on either side of the mesencephal.

Pigment is plentiful in the metaplexus and supraplexus; it also occurs upon the dorsal surface of the diencephal and mesencephal and the lips of the metacœle caudad of the metaplexus.

The meninges and blood supply of the brain have received but incidental attention here. As regards the former, however, as far as observed, the conditions in *Necturus* appeared to agree closely with those observed by Mrs. Gage ('93) in *Diemyctylus.*

The blood supply of the brain in *Amphibia* has been worked out by Schobl ('82) and Rex ('92); by the former on a number of urodeles of which *Necturus* is one. No attempt has been here made to verify his accounts, save that, as found by him, the capillary loops which penetrate the brain from the vessels lying on the surface, although generally stopping at the margin of the entocinerea, or penetrating it for a short distance only, were also occasionally seen to reach the layer of endymal cells.

CRANIAL NERVES.

No attempt has been made to study the peripheral distribution of the cranial nerves; and, in fact, the apparent need of it, existent at the time of Osborn's investigations, has been largely obviated by the later publication of Strong, Von Plessen and Herrick. The cranial nerves of *Necturus* have also been described and figured in some detail by Fischer ('64), although some evident errors occur in his work.

The description of the proximal relations of the several nerves given here is based upon a series of sections through a skull hardened in Hermann's fluid supplemented by macroscopic dissections of decalcified specimens.

I. The olfactory nerves are the largest of the cranial nerves and arise from the ventro-lateral angle of the olfactory

lobes as a single root, agreeing in this respect with *Desmognathus* and *Amphiuma* rather than *Cryptobranchus*, *Diemyctylus* and *Triton* in which two roots have been found to exist by Wilder ('89), Mrs. Gage ('93) and Burckhardt ('91) respectively. The nerves are quite long, dividing soon into numerous branches which are distributed to the olfactory capsules. In the larva these nerves are short, the fibers being given off laterad directly to the olfactory capsule which closely adjoins the brain.

II. The rudimentary condition of the eyes in *Necturus* is naturally accompanied by a similar condition of the optic nerves. The primitive lumen of the optic vesicle is persistent and the nerves are hollow for a considerable distance peripherad. This fact has been already mentioned by Osborn ('88) and Herrick ('93, 2). Furthermore, the optic fibers in *Necturus* are entirely amyelinic, at least in their course in the optic tracts and the central portion of the optic nerve. This was ascertained both from Weigert and osmic acid preparations. The specimens were fully mature adults measuring over 30 centimeters in length. This condition in *Necturus* is not, however, unique; Edinger ('92) found that in young frogs and in young adult Tritons and Salamanders the optic fibers were almost entirely amyelinic.

III. The oculomotor nerve takes its origin at the usual point in the floor of the mesencephal. Though small it was always readily found.

IV. The trochlearis could always be easily detected, but I was unable to trace it to its exit from the cranium. A large number of its fibers immediately after its decussation were distibuted to the metaplexus. It is possible that such fibers represent a sensory contingent of the 4th nerve. Gegenbaur ('70) has stated that the fourth nerve contains sensory fibers in selachians and Amphibia. Strong ('90) likewise, found in the tadpole a sensory intracranial branch. No ganglion was observed, however, in *Necturus* though numerous cells occurred among the fibers of this nerve.

V. The trigeminus is of good size in *Necturus*. It arises in the usual place in *Amphibia* and passes latero-cephalad to

enter the Gasserian ganglion which is situated extra-cranially. From this ganglion arise the usual three branches, exclusive of several small twigs composed of fibers from the branch of the "dorsal" seventh which is associated with the Gasserian ganglion.

VI. The abducens is quite small, being in fact the least of the cranial nerves. It arises a short distance caudad of the seventh, from the ventral aspect of the metencephal. It passes laterad to the seventh, with which it is associated for a short distance, though always distinct from it. It soon leaves it, however, to pass cephalad to the Gasserian ganglion, immediately ventrad of which it lies.

Dorsal VII. By this name, employed by Strong ('95), will be designated a nerve which until recently has been little understood. It leaves the oblongata at about the level of the exit of the facial proper, and immediately divides, one branch joining the trunk of the seventh and eighth nerves, the other passing cephalad to the Gasserian ganglion, with which its ganglion is fused, lying just dorsad of it. This nerve becomes ganglionated slightly before the fifth, however. A very small bundle of fibers leaves it just centrad of the ganglion to join the 7th nerve just before it enters the ear capsule. From its ganglion two or three small roots pass immediately dorsad; a large part of the fibers pass cephalad in company with the ophthalmic branch of the fifth, the ramus ophthalmicus superficialis VII, Strong. By Von Plessen ('91) and C. J. Herrick ('94) this branch to the Gasserian ganglion has been considered as belonging to the trigeminus, clearly, however, without recognition of the ultimate distribution of its fibers to the sense-organs of the lateral line system, as worked out by Strong. The reference of this nerve to the seventh is based merely on the fact of its exit from the brain being very close to that of the seventh proper. It belongs however to a system peculiar to the *Ichthyopsida*, and until more is known of its origin, and of the segmental value of the other cranial nerves, a reference of this nerve to the seventh must be merely a matter of convenience. The other division of the dorsal seventh will be spoken of with the following nerves.

VII, VIII. The facial and auditory arise very near together and form a single trunk which is joined by the ventral half of the dorsal VII and becomes ganglionated a short distance from the brain. From this ganglionic complex, composed of the acustic ganglion and the ganglion of the seventh (geniculate g.) one division of the eighth passes laterad to enter the auditory capsule. A very small portion of this pierces the capsule by a separate foramen but immediately unites with the larger portion. The remainder of the acustic fibers, representing presumably the *ramus utriculi*, together with the facial nerve and the dorsal VII, passes latero-cephalad to enter the otic capsule. Before it emerges there is given off the palatine nerve which leaves by a separate foramen. Immediately on its leaving the otic capsule, the seventh enters a ganglion of large cells, beyond which it divides into its several branches. This ganglion is stated by Strong to belong to the fibers of the Dorsal VII component. It is not mentioned by Herrick, but is figured by Von Plessen. The customary communicating branch between the ninth and the seventh exists in *Necturus*.

IX, X. The glossopharyngeal and vagus arise by three divisions, the more cephalic being the ninth and the representative of the lateral nerve of "fishes" (Strong), while the tenth arises farther caudad by several roots in two (or three?) groups. All these proceed latero-caudad to enter a ganglionic complex, from which six nerves emerge.

XI. The question of how far the eleventh nerve of higher forms is represented in Amphibia is a difficult one. By most investigators a spinal accessory is not recognized in Amphibia. Strong, ('90) in his preliminary paper upon the cranial nerves of Amphibia, regarded the more caudal root of the vagus as probably representing the cranial portion of the eleventh; in his final paper, no further mention is made of the eleventh, and this root is there spoken of as part of the X. Mrs. Gage ('93) and Fish ('95) both regarded the caudal root as the XI. The writer is inclined to believe that the cranial and possibly the spinal division is represented by a portion at least of this root. The morphological significance of the eleventh nerve is

however too obscure to admit of any confident homology being made.

XII. The hypoglossal in Amphibia is generally described as formed by the union of the ventral trunks of the two nerves arising immediately caudad of the vagus group, to which dorsal roots are wanting. According to Fischer ('64) however, *Necturus* forms a single exception to this rule, and the following is quoted from him: "Der *Hypoglossus* der Perennibranchiaten und Derotremen erinnert durchaus an die Formen der Salamandrinen. Er wird überall aus den *Rami descendentes* der ersten Halsnerven zusammengesetzt und zwar meist des ersten und zweiten. Nur bei *Menobranchus* entsteht er durch Verschmelzung des zweiten und dritten. Der erste Halsnerv dieser Gattung hat nämlich einen selbständigen Verlauf. Aus nur einer ventralen Wurzel entsprungen, tritt er durch ein im Seitentheil des dem ersten Halswirbel angehörigen Körpers hervor, wendet sich dorsalwärts und verbreitet sich in dem kurzen *M. occipitalis minor* (vom ersten Halswirbel an die obere Fläche des Hinterhauptbeins). *Menobranchus* ist übrigens die einzige Gattung, bei der ich einen dem *N. accessorius Willisii* entesprechenden Nerven von ganz selbständiger Form fand. Diesem Umstande entsprechend sind es nicht der erste und zweite, sondern der zweite und dritte Halsnerv, die bei dieser Gattung sich zur Bildung des *N. hypoglossus* vereingen." The peripheral distribution of these nerves was not traced sufficiently far to render a corroboration of the above possible. The following observations, however, regarding these nerves, are of interest. The first two nerves caudad of the vago-glossopharyngeal group, have in *Necturus* no dorsal roots or ganglia. They arise in the manner customary for the ventral roots of spinal nerves, by three rootlets from the ventral aspect of the myel (or oblongata), the more cephalic at just about the point where the neuraxis enters the cranium, and indeed from the oblongata, if the metatela is regarded as demarcating its extent. The second has its origin some distance caudad. Each nerve extends caudad some distance before leaving the spinal canal, and immediately upon issuing from it divides into two branches, one of which

passes dorsad to muscles, the other caudad and ventro-laterad. The ventral root of the third nerve, which is a complete nerve with dorsal root and ganglion, arises like the first and second. It passes obliquely latero-caudad to leave the canal in company with the dorsal root, which joins its ganglion just ectad of the foramen. The ventral root, lying mesad of the ganglion, divides into three parts, each of which is joined by bundles from the ganglion. One passes directly dorsad, the second laterad to break up immediately into a number of branches, while the third and largest division passes directly caudad, fusing with the caudal portion of the ganglion. Fischer's recognition of the first of these nerves as a spinal accessory cannot be agreed to, because of its mode of origin from the extreme ventral aspect; and its distribution, in part at least, is not comparable with that of the 11th. It is preferred here to speak of these nerves as the first, second and third spinal nerves, although the area of the hypoglossal is supplied from some of their branches. An indication of a dorsal root for the first of these has been found by Kingsley ('92) in *Amphiuma* and by Mrs. Gage ('93) in the larval *Diemyctylus*.

GENERAL MORPHOLOGY.

Rhinencephal. In the application of this term to the olfactory lobes in *Necturus*, it is not the intention to convey a prejudgement of the interesting problem as to whether or not they are entitled to recognition as constituting a separate segment of the brain. It is possible indeed that the olfactory lobes and the portions of the cerebrum which are associated with the sense of smell, constituting, it is believed, almost the entire secondary forebrain in the *Necturus*, should properly be regarded as representing a single primitive segment,—Rhinencephal. Turner, followed by Schäfer and Edinger, who extend the application, has applied the term rhinencephal to such portions in higher forms, not employing it in a segmental sense, however. As has been insisted by Wilder ('93) Rhinencephal used in its true segmental sense should include mesal (portion of aula), as well as ventral, portions of the parietes. Mrs. Gage ('93) from the

study of the brains of embryo *Diemyctylus* and the Lamprey states that "upon embryological grounds it seems as though the rhinencephal were equally entitled with the prosencephal to a share of the aula as a mesal cavity."

It is difficult to determine how much of the combined olfactory lobes and cerebrum in *Necturus*, may be considered as belonging to the former. A slight vertical furrow upon the endymal surface of the mesal walls, slightly cephalad of the caudal limit of the olfactory glomerules, may possibly be regarded as indicating its limit, in the mesal walls. The horizontal sections, Figs. 34 and 35 show the general relations. The olfactory nerves spring from the lateral and ventro-lateral portion of the lobes. Completely encircling the olfactory glomeruli, in which the nerve fibers end, is an area of ectocinerea, first appearing on the lateral aspect and spreading cephalad, both dorso-mesad and ventro-mesad, to complete the circle in the cephalic portion of the mesal surface of the apposed lobes. A slight furrow outlines this area so enclosed, more marked on the lateral surface, fainter on the dorsal and ventral aspects. Fig. 33 shows a transection through this region of the brain.

Prosencephal.—The prosencephal is of the characteristic amphibian form and structure. The extent and relations of alba and cinerea are shown in the series of transections, Figs. 28-33, 42. The ventro-lateral walls, in which the peduncular tracts are lost, representing undoubtedly the basal ganglia of Edinger, the striatums, form but faint swellings into the paracœles, these being most marked in the region of the portas. The mesal walls are spoken of subsequently in connection with the cerebral commissures. The entocinerea extends to the ectal surface of the prosencephal only in three places,—(1) at the caudal ends of the cerebrums where the walls are quite thin, (2) at the meson in the terma cephalad of the cerebral commissures, and (3) in the mesal wall cephalad of the terma ; here it is quite extensive. Immediately cephalad of the terma the mesal walls of the cerebrum are formed only of pia and endyma which in the region consists of two to three layers of cells (Fig. 31). This is soon succeeded farther cephalad by true nervous parietes

in which the nerve cells extend to the exterior, generally associated together in small clusters. It is believed that the relations in this region cephalad of the terma are important in view of the relations in the Reptilia and the possible homology of the hemiseptum (septum lucidum).

Paraphysis. This is quite large in *Necturus*, and enveloped in and distorted by the supraplexus ; it extends cephalad closely applied to the roof of the skull. The communication with the cavities of the brain in the adult was constant, ageeing in this respect with *Diemyctylus*. In *Amblystoma* ('92) the communication with the cavities of the brain was found to become interrupted in larvæ twelve millimeters in length.[1] In the just hatched larva (*Necturus*) the weak development of the supraplexus leaves the parts in a simpler condition, and the paraphysis appears as an elongated sack lined by a single layer of cells, (Fig. 8) and communicating with the encephalic cavities by a narrow neck.

In the greatly elongated terma, which in *Necturus* forms in part the floor of the brain, immediately caudad of the portas, is a marked shelf-like elevation in which cross from side to side two bundles of fibers, the more ventral, the precommissure, and the dorsal, the callosum, generally recognized as such hitherto. The correctness of this homology seems doubtful, and in order not to prejudice the question in the outset, it will be here spoken of as the dorsal bundle or commissure. There has been great difference in the statements made concerning the relations of this bundle to the precommissure in *Necturus*. Osborn ('86) in his memorable paper on the "Origin of the Corpus Callosum" mentions and figures the dorsal bundle,—his callosum—as completely separated from the ventral by a part of the cavity and a fold of the plexus, and he further found the same condition in *Proteus*. Herrick ('93, 3) speaks as follows of the relations of these commissures in Necturus :

[1] In his paper on the development of *Amblystoma*, which has just appeared ('95) Eycleshеimer reiterates the statement of the obliteration of the proximal portion of the cavity of the paraphysis, and a discussion of the significance of the organ is given.

"In Menobranchus [Necturus] however, he [Osborn] makes the significant discovery that the upper bundle is completely separated from the lower and crosses the ventricle independently, so that a fold of the vascular plexus of the pia [*sic*], which in this genus is greatly developed, passes through the interspace. This statement of Osborn we had overlooked, but upon theoretical grounds suspected that the dorsal commissure would prove to belong to the roof and not to the floor of the ventricle. We, therefore, had introduced the accompanying drawing (Plate IX, Fig. 5) before noticing that Osborn's Fig. 14 is substantially identical. We have never found the dorsal commissure so completely separated as represented by the latter, but always in juxtaposition with the floor; it was therefore a matter of congratulation to find a clearly defined continuous film of epithelium separating it from the subjacent pre-commissure. The series being continuous and faultless and doubly stained with hematoxylin and fuchsin to differentiate epithelial from nervous elements the evidence is conclusive. Knowing, as we now do, that the plexus is but a diverticle of the roof we recognize of necessity that the commissure is morphologically dorsal." Thirdly, Fish (21) in connection with the homology of this commissure in *Amphibia* with the callosum of mammals, from the examination of a larval and adult *Necturus*, reports "a non-separation of these commissures except by a simple cellular layer." The results of my own observations differ entirely from those of the investigators mentioned above. Twelve adult brains were examined in this connection, and in no one of them was there a separation at the meson, by cells, endymal or otherwise, much less by an extension of the cavity and a fold of plexus. The dorsal bundle rested immediately upon the ventral, the precommissure. The dorsal bundle turns dorsad to the mesal wall of the hemicerebrum while the ventral passes directly laterad so that on each side of the meson cinerea becomes interpolated between them. In five larval forms examined the condition was precisely that found by Mrs. Gage in larval *Diemyctylus*; in these the separation of the two commissures is by three or four layers of cells which in no way dif-

fered in appearance from the cells of the surrounding cinerea, nor was the more dorsal layer differentiated from the rest as a layer of endymal cells. Mrs. Gage found this condition of a separation by cinerea to persist quite late in *Diemyctylus*, and it was present even in some young adults. It is possible that the same may be true in *Necturus*, which would account for the results of Herrick and Fish, if the individuals examined by them were young. The brain upon which Osborn's figures and conclusions were based must have been abnormal in the relation of these two commissures.

The presence of cells separating the two commissures is seen from the larval conditions to be insignificant, but the recognition of these cells as endymal, as has been done by Herrick would be vital. In the distribution of the fibers of the dorsal bundle in *Necturus*, the observations of Osborn and Herrick are in the main here confirmed. Whether or not this commissure can be regarded as the representative of the mammalian callosum as first prominently advocated by Osborn seems doubtful. In view of the differences which exist in the interpretation of this bundle in Amphibia, and the importance of the question, a brief review here of the history may be warranted.

Although a callosum had been ascribed to Amphibia previously, Reissner (1864) was the first to accurately figure in *Bufo* the bundle in question, which he regarded as a callosum. Following him, Stieda ('70) rejected the homology of callosum and regarded it as the *pars olfactoria* of the precommissure. This latter view was then generally accepted by the investigators who followed him,—Goette, Bellonci ('82 and '83), Rabl-Rückhard ('83) and Osborn in his papers of 1883-4, until the appearance in 1886 of Osborn's paper on the origin of the callosum, in which occurs the statement of the peculiar relation of the dorsal bundle in *Necturus* to the precommissure, before mentioned, and also the following statement of the relations of this bundle:—"An important character is that the cerebral commissures in the Amphibia lie *behind* the foramina of Monro." Again:—"The upper bundle [his callosum] ascends in the median hemisphaeral walls, forming the posterior boundary of the

foramen of Monro, and then turns forwards roofing the foramen."

In the following year Bellonci ('87) published a paper on the anterior commissure in Amphibia and reptiles, in which he states his inability to accept Osborn's conclusions and reaffirms the declaration made in his former papers ('82 and '83) that decussational as well as commissural tracts occur in this bundle, his "*tratto superiore della commissura anteriore.*" In the Triton he found the fiber bundles which constitute the dorsal commissure coming from four regions: (1) 'those lobes which in their anterior lower and lateral parts contain the olfactory glomerules'; (2) the mesal wall of the hemispheres; (3) the caudo-lateral part of the same; and (4), the 'region of transition between the cerebrums and thalami' and especially from two ganglia dorsad of the portas.

In 1888 appeared Osborn's paper ('88) containing the following comment upon Bellonci's criticism: "I have seen reason to partly alter my views as to the nature of the commissures of the hemispheres which were described in detail in my paper on the corpus callosum. The more recent researches of Bellonci, with the aid of the Golgi method, upon these commissures, should be consulted. They show that with the purely commissural fibers, decussational fibers are intermingled. I have myself discovered that in the upper bundle or corpus callosum of *Menobranchus* [*Necturus*] there enter fibers from the diencephalon." He reaffirms, however, the entire separation of the dorsal bundle from the ventral in *Necturus* and *Proteus*.

With the exception of Bellonci and Herrick (to be mentioned presently) the investigators following Osborn,—Köppen, Edinger, Burckhardt, Mrs. Gage, and Fish, none of whom except the last discuss the question to any extent,—all recognize the homology set forth by him. Edinger ('88) states the opposed views of Osborn and Bellonci without comment, but in his figures names the tract callosum. Burckhardt ('91) seems to have recognized both a callosum and the superior tract of the anterior commissure of Bellonci, not aware apparently that the two are identical.

The views of Herrick may be gathered from his several papers in the Journal of Comparative Neurology. The dorsal commissure he considers as representing the hippocampal or fornicommissure: as representing a callosum, he figures fibers in the mesal wall cephalad of the porta, though in his last reference to the subject he considers that it might be "possible that callosal elements were bound up in the larger hippocampal commissure."

The distribution of the fibers of the commissure in question is shown in Fig's. 29-31; 34, 35, 38, 39 and 42, which in the main agree with those of Osborn and Herrick. The results attained also agree with those of Bellonci; the extension of fibers into the olfactory lobes is not affirmed as definitely by him as his general statements would indicate. In *Necturus* by far the largest portion of the fibers spring from the mesal walls of the hemicerebrums both cephalad and caudad of the portas. This mesal wall has been well described by Mrs. Gage in *Diemyctylus* and the name *callosal eminence* is applied to it. It forms a prominent swelling into the paracœle, and is characterized by its scattered cells which Nakagawa ('90) considered as constituting a rudimentary cortex. By Edinger ('88), the mesal wall both in *Amphibia* and reptiles has been regarded as representing the hippocampal region in higher forms. Herrick likewise, though in his earlier papers he seemed to confine the homology to the caudal region alone, has stated in his last reference to this question ('93, 3) that the caudal and mesal walls in *Necturus* may confidently be homologised with the hippocampus. Some fibers could be traced to a point slightly cephalad of the caudal limit of the olfactory glomerules on the lateral aspect, or just caudad of the endymal furrow in the mesal wall already spoken of as possibly marking the limit of the olfactory lobes.

These various tracts unite to form a single bundle which passes caudad over the porta, of which it forms the roof, and with another bundle from the dorso-mesal wall, and a small contingent from the diencephal, passes ventrad to cross in the terma or floor, immediately dorsad to the precommissure,

as stated before. The derivation of a few fibers from a nidus of the diencephal was unmistakable (Fig. 29); they correpond presumably with the fibers from the diencephal described by Bellonci in the Triton. These are in addition to other fibers, some medullated, which pass into the mesal wall from a more dorsal region of the diencephal,—probably the habenas. Fig. 29 shows a transection through the cephalic end of the group of cells from which the first named fibers spring. It lies dorsocaudad of the porta. Whether or not these bundles are decussational or commissural, or both, could not be determined from the specimens.

In the larva, as before stated, the dorsal commissure crosses in the floor, separated from the precommissure by several layers of cells. In the just hatched larva the fibers after crossing turn caudad and dorsad in the mesal wall of the hemicerebrum and could be followed to the point where the prosencephal and diencephal join. A derivation at this stage of some of the fibers from the diencephal was strongly suggested but not demonstrated.

Manifest difficulties attend the homology of this tract with any of the mammalian structures with which it has been compared, and the questions of the development, and relation to each other, of the callosum and hippocampal commissure are intimately connected. Herrick ('93, 3) has regarded this as a purely hippocampal commissure with possibly callosal elements in it. This homology, however, he apparently made dependent on the recognition of this tract as dorsal.

It is felt that the concurrent evidence of *Diemyctylus*, *Desmognathus* and *Necturus* shows quite conclusively that the fibers of this commissure cross in the terma and do not belong to the roof and simply rest upon the precommissure as thought by Herrick, or cross separately and independently in *Necturus* as stated by Osborn. It is possible that the recognition of this commissure as belonging to the terma might modify Prof. Herrick's views of the strict homology with the hippocampal commissure.

The homology that has generally been recognized for this

commissure, that of a callosum, involves the general problems just mentioned. The recognition of this as a callosum, it is thought is open to serious objections. It would not be expected that a commissure which in Mammalia is very largely, at least, a cortex commissure, would be present in so well developed a condition in forms in which no true cortex exists. This suggests, of course, the question of how far ectocinereal areas may be represented by non-migrated entocinerea. The regions to which these fibers are distributed have been regarded as an incipient cortex, it is true, but they are also considered as representing the hippocamp, and the question of the homodynamy of callosum and fornicommissure arises. Far more serious than objections such as the above seems the morphologic one suggested by the relation of this bundle to the portas. The fibers collect from the mesal wall, pass ventrad, *caudad* of the porta and cross in the terma. In no way does it appear possible to homologize such a bundle with one whose fibers arise in the dorsal or mesal walls of the hemicerebrums and cross in the terma *cephalad* of the portas. This peculiar relation in Amphibia is commented on by Osborn as was noted. He evidently saw in it nothing to invalidate the homology of the tract to the callosum. The objection however seems to the writer to be a vital one.

Fish ('95) contends at some length and forcibly for the homology of the dorsal commissure with the callosum of mammals, or callosum-fornix as he believes, and presents as forming a series illustrating the transition from the condition in urodeles to that of reptiles and birds, mesal views of the region of the terma in *Desmognathus*, *Cryptobranchus*, frog, turtle, and bird. I cannot consider these forms as entirely comparable in this respect; the relations at the meson seem to me to be misleading. The difficulty lies not in the relations here but in the distribution of the fibers as regards the portas. In Amphibia (frog included) the fibers pass dorsad to the mesal walls *caudad* of the portas as already stated, while in reptiles they pass *cephalad* of of the portas. It is evident that however far cephalad and dorsad the terma might be bent, the relations in Amphibia could

only be directly changed into those of higher forms, by the migration of the bundle in question across the portas.

It is to be regretted that no satisfactory solution of the difficulties involved can be offered here. It is believed as stated by Herrick that the "whole question as to the relation of the calloso-fornix structures requires special consideration on the widest possible comparative grounds." A callosum at least seems to be entirely absent. I fail utterly to find any trace of a commissure in the terma cephalad of the porta where Herrick has figured it in *Necturus*. Judging from the figures and statements of Edinger, Herrick and Meyer, what has been called the hippocampal commissure in Reptiles lies caudad of the portas in the roof; hence the readiness with which Herrick considered the commissure in *Necturus* a hippocampal commissure, since he regarded it as dorsal. A comparison with the cerebral commissures of the reptilian brain has not been made in this investigation and an expression of opinion cannot be given as to the comparability of the relations in Amphibia and reptiles. It is believed, however, that this commissure will prove, in part at least, a hippocampal commissure.

Whatever may be the result of exact comparison with the cerebral commissures of Reptiles, it is felt that a representative of this commissure should be looked for in other *Ichthyopsida*, which have other characters of the brain in common. It is hardly necessary to mention the importance of a knowledge of the relations that the cerebral commissures have in the three Dipnoans. Burckhardt (9) has found it in the brain of *Protopterus* and calls it a callosum, but he says nothing of the distribution of the fibers, nor do his figures afford a solution. *Ceratodus* and *Lepidosiren* yet await investigation. The fact that in *Petromyzon* a cerebral commissure has been recognized in addition to the precommissure, lends the hope that the conditions there may be found to compare closely with those in urodeles, the general resemblance between whose brains has been noted by Wilder ('76). Mrs. Gage has contrasted transections through the cerebral commissures in *Diemyctylus* and *Amia*, and has suggested that the (ventrally) recurved portion of the cere-

brum may be equivalent to the mesal wall (callosal eminence) in *Diemyctylus*, in which case the membranous roof of the fish cerebrum would represent the crumpled plexuses of higher forms. This view has been endorsed by Studnicka. We might then expect to find in ganoids a commissure exactly comparable to that found in Amphibia.

The projection of the terma into the aula noticed by Mrs. Gage in Diemyctylus and Amia, to which she applied the term *crista*, (a name given by Wilder ('80) to a similarly situated object discovered by him in the mammalian brain) exists in *Necturus* merely as a slight intrusion of the pia covered by endyma. It is in this region that Herrick has figured fibers which he considered a possible callosum. As before stated, I fail to find any trace of such.

Diencephal.—This and the following segment are but slightly differentiated from each other ectally. Upon the dorsum a slight transverse furrow dorsad of the postcommissure, and the prominent caudal bend of the dorsal wall of the infundibulum on the ventral aspect, may be regarded as boundaries. Cephalad of the postcommissure, which may be considered as limiting the caudal extent of the segment in the roof, the solid walls of the diencephal become divaricated and the roof at the meson is formed by the endyma and pia alone. This consists of a single layer in its cephalic portion passing caudad into the peculiar several-layered endymal structure ventrad of the postcommissure, which has been described by Mrs. Gage ('93). At the supracommissure the walls approach to separate yet more widely cephalad of it, where the roof, diatela, is greatly expanded, limited cephalad by the velum; this is oblique, so that a large sac is formed dorsad of it, extending also laterad at each side cephalad of the habenas; it is the *postparaphysis* of Herrick ('93, 2), by whom the *paraphysis* is termed the *preparaphysis.*

Epiphysis.—This in *Necturus* consists of an aggregation of closed vesicles, forming a flattened suboval body upon the dorsum of the brain between the post- and supracommissures. Fig. 23 shows a transection of it. No connection with the dia-

cœle was found, however, as is said by Herrick to be the case. In the just hatched larva the condition was simpler, the epiphysis at that stage being a simple hollow vesicle, not communicating even at this early stage with the brain cavity. Two or three myelinic nerve fibres, one each side, were found to pass to the ectal surface of the brain and disappear after turning mesad beneath the epiphysis. They came from the mesencephal to which they could be traced caudad. This fact is presented without comment, but is interesting and suggestive in connection with what has been written regarding a parietal nerve.

Paraphysis, etc.—Three evaginations of the roof of the brain have been recognized, all of which may be present in the same form, viz., (1) the epiphysis between the post- and supracommissures; (2) cephalad of the supracommissure an evagination which has been variously termed zirbel-polster, polster, dorsal sac, and postparaphysis; (3) the third farther cephalad, separated from the second by the velum, and here called *paraphysis.* An admirable résumé of the literature of the subject is given by Sorensen ('94, 1) by whom the term *paraphysis* includes the two more cephalic evaginations, which he considers are caused by the division of his paraphysis by the velum into cephalic and caudal portions, the *pre-* and *postparaphysis.* He says of these ('94, 2): "The causes for the varied forms found in the *paraphysis* must, we think, be sought for in the mechanics of embryonic growth and development, and, as already remarked, to call these sac-like projections *epiphyses* is absurd, as their structure and position prove their plexiform origin." There is entire agreement with the above as regards what has been called "*postparaphysis*" in Amphibia. In the just hatched *Necturus*, the parts lie much nearer together. The walls of the diencephal extend cephalad between the cerebrums quite to the velum and there is not the extent of the tela in this region that there is in the adult. The simple diaplexus arises from the velum. But while there is no indication of an evagination caudad of the velum, the *paraphysis* cephalad of it is well developed as a bulblike sac communicating with the brain cavities by a constricted neck. In Amphibia, at least, the *preparaphysis*

and *postparaphysis* of Herrick do not seem to be structures at all comparable. The extent of the diatela in *Necturus* appears to be due simply to the elongated condition of the brain; the supraplexus extends cephalad closely applied to the roof connected with the dura. The velum extends ventro-caudad, forming dorsad of it the apparent evagination.

Plexuses.—The plexuses of the prosencephal and diencephal are greatly developed in *Necturus*; the relations, however, are as Mrs. Gage has shown in *Diemyctylus*, and the names applied by her are here adopted. The *auliplexus* intrudes into the cavities cephalad of the *paraphysis*. It sends extensions through the port as intothe paracœle and another division caudad into the infundibulum. The diaplexus arises from the velum and the diatela and extends caudad to the cerebellum, occasionally protuding caudad of it into the metacœle. In the larva the plexuses are much simpler than in the adult, and the relations set forth above are much more easily seen.

On the dorsal edge of the divaricated walls cephalad of the supracommissure are situated the habenas. Caudad of the supracommissure in a similar position and extending almost to the postcommissure is another nidus of cells similar to those of the habenas probably representing Meynert's nidus, since Meynert's bundle seems to spring from here. Dorso-caudad of the portas lie the cell areas from which spring fibers which join the dorsal cerebral commissure. This is molded about a core of alba from which the fibers arise, and is bounded dorsally by a well marked sulcus, which extends caudad, growing fainter to again become distinct in the caudal region of the diencephal. On the floor of the brain caudad of the cerebral commissures is the cephalic projection of the cavity, the preoptic recess, from the caudal portion of which and cephalad of the chiasma the optic recesses project laterally to constitute the lumen of the hollow optic nerve, as already mentioned. The infundibulum, as in other urodeles, is large, extending caudad so as to completely conceal the mesencephal. The hypophysis is attached to the caudal end of the infundibulum, whose cavity extends dorsad of it as the *saccus vasculosus*.

Mesencephal.—(Figs. 1, 4, 21, 22.) The dorsal aspect is slightly more convex than that of the preceding segment, from which it is ill defined. No mesal furrow was found indicating a pair of gemina. Upon the ventrimeson its extent is limited, extending from the infundibulum to the Mittelhirngrube of Burckhardt, the Isthmusgrube of His. Considerable morphological importance has been attached to this depression; it forms a convenient landmark and will be designated here as the mesencephalic pit. It seems to be much more marked in *Necturus* than in other urodeles, the cinerea at the meson consisting of but two layers of cells and reaching the ectal surface of the brain. Cephalad of this have been located the region of the albicantia and the *corpus interpedunculare.* The oculomotor nerves also leave the brain in this immediate neighborhood.

The entocinerea forms a continuous mass surrounding the mesocœle. A differentiation into zones such as occurs in Anura and to a less extent in certain other urodeles, is not well marked in *Necturus*; an ill defined, discontinuous stratum of alba divides the entocinerea of each tectum into an ectal and ental layer, and in places a third is suggested.

Epencephal.—The cerebellum of *Necturus* is exceedingly simple and consists, as Osborn found in *Amphiuma,* of a small band of fibers passing from one side to the other, and "containing no cells save the simple endyma."

The question as to whether or not the epencephal should be recognized as constituting a segment of equal value with the others is a difficult one, and indeed the indication of a division into segments is very obscure. Certainly, in urodeles, there is nothing except the exceedingly rudimentary cerebellum to represent that which in higher forms attains so great a development; and, viewed from the condition in urodeles alone, the inclusion of cerebellum and oblongata by His under a single segment, would appear justifiable. The term applied by him, *Rhombencephalon,* or Rhombencephal, is however open to criticism since the same name had been previously applied to the lumbar enlargement of birds. This is, how-

ever, a question for comparative and developmental study. It has been discussed somewhat by Wilder ('84) and by Stroud.

Metencephal.—This segment may be regarded provisionally as co-extensive dorsally with the membranous roof, the metatela. In *Necturus* this portion of the brain is extremely long, equalling indeed, the length of the entire brain cephalad of it, and accepting the limit here given, is not contained within the cranium but extends caudad into the first vertebral arch. The transition in structure to the myel is gradual, as usual. The myelocœle expands gradually to form the metacœle which widens cephalad to the region of the fifth nerve. On each side of the cerebellum well marked lateral recesses extend cephalad. The analogy of these to the lateral recesses or parepicœles of higher forms has been suggested, and a comparison with the similarly situated restiform bodies of sharks and rays may perhaps be made. There is a mesal sulcus in the floor of the metacœle, beginning near the exit of the 9th and becoming most marked in the region of the 5th nerve, cephalad of which point it soon disappears. This and the sulcus at the point of junction of the wall and the floor appear to be the only depressions which might be regarded as of structural importance. There is no sulcus just laterad of the fibre bundle on each side of the meson, such as occurs in many other forms.

The metaplexus occupies but a portion of the roof of the metencephal, the remainder being a simple tela. It (the metaplexus) is highly pigmented and extends from the region of the tenth nerve to slightly cephalad of the 7th, and laterally, cephalad over the lateral recesses, overlapping slightly the parts to which it is attached. Its relations and the regular arrangement of the folds which project into the metacœle can be seen from Figs. 1 and 6. The remainder of the roof is a simple tela; no metapore, or foramen of Magendie such as occurs in *Diemyctylus* (Mrs. Gage '93) was observed. In its caudal portion, however, the metatela was very thin and often ruptured.

Opposite the exit of the tenth and caudad of the meta-

plexus, the lateral edges of the walls were approximated to a greater or less degree. The same condition was observed by Osborn ('88) in *Proteus*, and Mrs. Gage in *Diemyctylus*. At this point the pia is much thicker and it is thought possible that it may be due merely to a spreading of the parts caudad, producing thus this appearance.

Endolymphatic sacs.—In *Necturus* as in other Amphibia, these come into close relations with the brain. The endolymphatic duct pierces the ear-capsule by a separate foramen and expands into a simple sac which rests upon the metaplexus in the immediate neighhorhood of the seventh and eighth nerves. Its diverticles are few and very small, attaining in no way the extent and complexity found in the frog and by Mrs. Gage in *Diemyctylus*, where there is a communication of the two sacs across the meson. Burckhardt has found the same relations of the *saccus endolymphaticus* in *Protopterus* as in Amphibia: the sacs are of great extent and divide into numerous diverticles, but do not communicate across the meson. In the larval *Necturi* examined the conditions were as in the adult,—the sacs small and simple. In connection with the simple relations of the *saccus endolymphaticus*, it may be mentioned that no periganglionic glands were observed on either the Gasserian or spinal ganglia, as in the frog.

Myel.—This has received but slight attention from me, the portion immediately adjoining the brain only being examined. In form it is subcylindrical, differing in this somewhat from *Cryptobranchus* and *Siren* (Kölliker, '93) in which it is more or less flattened. No marked cervical enlargement was observed. A dorsal furrow appeared to be wanting; the ventral one is well marked. A *ligamentum denticulatum* exists in the adult *Necturus*, where it forms a cord closely applied to the latero-ventral aspect of the myel, which it leaves at intervals to pass to the wall of the vertebral canal, apparently at the points of articulation of the vertebrae; the myel was not studied for a sufficient distance, however, to warrant a positive statement as to the relations of the ligament.

The myel of Proteus has been studied by Klaussner ('84).

HISTOLOGY.

Oblongata.—The account of this important portion of the brain is very incomplete, from the lack of time and suitable material, as well as the natural complexity of its structure. In the adult the cells can be made to take the silver impregnation only with great difficulty, and the unavailability of fresh larval material has rendered very unsatisfactory the study of their relations. The form of the cells of the myel and oblongata in Amphibia has been shown by Fish and others. The cells of the dorsal and lateral regions are pear-shaped, the simple process extending toward the periphery and branching profusely. The motor or ganglion cells in the ventral and lateral regions are multipolar or fusiform and their processes extend peripherally into the alba and are greatly branched.

The transition from the myel to the oblongata is a gradual one ; even as far caudad as the second spinal nerve, the typical structure of the myel is somewhat modified. A transection of the cervical myel is shown in Fig. 9. In accordance with the conditions in higher forms, the alba may be divided, more conveniently than naturally perhaps, into dorsal, lateral and ventral columns. The compressed myelocœle is bordered by two or three layers of endymal cells. The dorsal and ventral cornua of the cinerea are present, but are weakly developed. The dorsal send projections ectad, interrupting and dividing into small bundles the longitudinal fibers of the alba. The cells in the myel are mostly small, their processes directed peripherally. In the ventral horns are the characteristic large cells, which also occur in the lateral region. Occasional fusiform cells were likewise observed which sent their processes into the raphé. The fibers of the ventral columns are mostly coarse, especially those immediately ventrad of the cinerea, the posterior longitudinal fasciculus and the Müllerian fibers of Osborn[1] with which are associated the large Mauthner fibers.

---

[1] Osborn is not quite clear in the terms in which he speaks of the fibers of this region. The fibers immediately ventrad of the cinerea on each side of the meson, he called the posterior longitudinal fasciculus ; those farther ventrad, Müllerian fibers, presumably from a supposed homology with the fibers of that

In the region of the second spinal nerve (non-ganglionated), the myelinic fibers of the dorsal columns have begun to decrease in number, almost all having disappeared save such as will constitute the ascending tracts of the fifth and tenth nerves, whose fibers begin to be recognizable at this level. From this point to the beginning of the metatela the change consists merely in a migration laterad of these tracts and the dorsal extension of the myelocœle. In the ventral regions of the myel changes are less marked and consist merely in a more compact arrangement of the fibers of the posterior longitudinal fasciculus. In the relations of the cell areas, the change from myel to oblongata is not so perceptible. A general view of the distribution of the cells in the oblongata may be given here. As the oblongata widens the general arrangement of cells remains much the same. The large cells of the ventral region are continued cephalad for some distance, but become more scattered beyond the tenth nerve; such cells are found, however, at intervals throughout the length of the oblongata, and in the region of the eighth nerves they are increased in number and size. The lateral cells of the myel become supplanted in posision by the motor nidi of the tenth, ninth and seventh nerves, which are not so distinctly demarcated in *Necturus* as in *Cryptobranchus* (Osborn, '88). Farther cephalad, the compact motor nidus of the fifth nerve succeeds in the latero-ventral region. The cells occupying the remainder of the oblongata, except large, laterally situated cells near the eighth nerve and similar cells more sparsely located, are small, —so called sensory cells—especially occupying the dorso-lateral cinerea and the region on each side of the meson, where be-

name in *Petromyzon*. If this were correct,—and it would seem but partially so, —no recognition of a distinction between the posterior longitudinal fasciculus and Müllerian fibers should be made, since in *Petromyzon* two or three Müllerian fibers continue cephalad as the axis of the posterior longitudinal fasciculus (in the restricted sense of Ahlborn). This bundle will be recognized here occupying its usual place just ventrad of the cinerea on each side of the meson, and many of the large fibers composing it seem to be comparable in their relations with the Müllerian fibers of the Lamprey.

tween the fifth and seventh nerves, they are quite abundant, forming prominences in the floor of the oblongata,—the *nucleus centralis* of Stieda.

Mauthner's Fibers.—(Figs. 9-16, 18.) It is interesting to observe the presence of the Mauthner's fibers in *Necturus*, adding another to the forms in which their occurrence has been noted. They appear to be quite constantly present in Teleosts where they have been studied by Stieda ('68), Fritsch, Mayser ('81), Kölliker ('93), and others. They also occur in Ganoids (*Acipenser*, *Amia*, *Polypterus*, *Calamoichthys*, *Scaphyrhynchops*,) and in Dipnoans (*Ceratodus*, *Protopterus*). On the other hand, according to Kölliker they are absent in five genera of teleosts[1] that have been examined and in the Elasmobranchs. In Amphibia they seem to be generally present in the larval state, and have further been observed in the adult *Triton* (Burckhardt '91), *Desmognathus* (Fish '93) ; I have found them in the adult *Necturus*, *Amblystoma*, and *Diemyctylus*. Osborn on the other hand states that they were not found in *Cryptobranchus* and are not generally present in urodeles ; the last statement would appear erroneous, however, from the enumeration above.

They are stated to be absent (as Mauthner's fibers) in the adult *Salamandra maculosa*, (Burckhardt, '91). In *Necturus* they occupy their customary position in the dorsal portion of the ventral columns, on each side of the meson. In this position they may be traced cephalad to their decussation just caudad of the exit of the seventh and eighth nerves, where they cross somewhat obliquely and turn directly laterad to end in,—it is believed,—large cells. They measure about 35 micra in diameter, being, it would seem, somewhat smaller than the corresponding fibers in "fishes;" (see Kölliker, '63). No apparent regularity seemed to exist in their relation to each other at the decussation, sometimes the right and sometimes the left crossing dorsad of its opposite.

[1] These are *Orthagoriscus*, *Tetrodon*, *Mormyrus*, *Malapterruus*, and *Gymnotus* ; it is interesting to note that the last three are electric or semi-electric fishes. The relation of the first two genera to Fritsch's theory is interesting.

The Mauthner cells[1] are very large, being fusiform in shape and lying transversely to the long axis of the oblongata. The mesally directed process was not seen to branch and is thought to be continuous with the axis cylinder of the Mauthner fiber. The lateral end divided into several (at least three) processes, which extended toward the entering fibers of the auditory nerve; (see Fig. 18.) These cells resisted the silver impregnation, and the exact extent and relations of the dendrites (processes) could not be observed.

The intimate relation of the processes with the fibers of the eighth nerve has been observed by Mayser, Goronowitsch, and Burckhardt. Goronowitsch was inclined to regard the processes as giving rise directly to acustic fibers,—a condition irreconcilable with the views at present held of the relations of sensory nerve fibers. Intimately connected is the question of the relation of other large cells to the eighth nerve.

The Mauthner fibers have not been followed in *Necturus* caudad of the third spinal nerve; as observed in other forms, however, they gradually become smaller caudad until near the caudal end of the abdomen they become indistinguishable. Stieda ('64) states further, that in Amphibia (*Axolotl*) they do not preserve their large caliber for such a distance as in fishes.

There is substantial agreement in the observations of different investigators as to the structure of the fibers in fishes and dipnoans. By all they are stated to be fibrillar and to give off twigs (collaterals?) at intervals. In dipnoans (*Protopterus* and *Ceratodus*) the fibrillar structure would seem to be particularly well marked. Sanders ('89) speaks of them in *Ceratodus* as multi-axial with axis-cylinders leaving the common sheath at intervals. In *Necturus* the fibers appear finely fibrillar, but no

[1]There would seem but little doubt of the direct continuity of the Mauthner fiber and cell. Mayser, ('43) in his investigation of the brain of the cyprinoids, discusses both fiber and cell at some length. He states the termination of the fiber in the cell. Goronowitsch ('28) in Acipenser, states the fact, or at least his interpretation, in the following clear language: "Nach der Kreuzung verlaufen sie bogenförmig zum Unterhorne, wo sie in sehr grossen Nervenzellen enden."

Furthermore, Burckhardt ('91) found both cell and fibre in Triton, and figures the former and its connection with the Mauthner fiber.

collaterals were observed to be given off in the limited distance that they were followed.

Of the various theories propounded to explain the function of these interesting structures, that of Fritsch is, perhaps, most plausible, viz., that they have to do with the co-ordination of the action of the lateral musculature in producing the rhythmic movements of the body and tail in swimming, coming into relation with the motor cells of the nerves by means of collaterals.

In connection with the theory of Fritsch, the discovery by Köppen of large fibers in the caudal myel of certain reptiles is certainly interesting and suggestive.

There would seem to be no necessary correlation between these fibers and an aquatic life as is thought by some, since they have been found in *Amblystoma*, which seems to lead a terrestrial life except during the breeding season.

The Mauthner fibers correspond closely in their relations with the median crossed Müllerian fibers of the Lamprey,[1] which arise (Ahlborn) from large cells near the exit of the auditory nerve, decussate, turning caudad in the myel, where they give off collaterals (Davis) and gradually diminish in size.

Ventral Tracts.—At the beginning of the metatela, the posterior longitudinal fasciculus occupies the same position as in the myel, situated on each side of the raphé, in almost immediate contact with the cells of the endyma, separated only by an occasional nerve cell ; in this position it traverses the length of the oblongata, the course being clearly marked in the floor of the ventricle as a white line at each side of the meson.

In Necturus, an oblique decussation of scattered fibers occurs cephalad up to the exit of the caudal root of the tenth nerve ; none was observed between this and the ninth. At the level of the ninth nerve, the root bundle of the seventh has taken its position between this bundle and the endyma of the

[1]The statement of Osborn ('88) and Burckhardt ('91) of the occurrence of Mauthner fibers in *Petromyzon* is inexplicable. The idea may possibly have been gathered from the paper of Fulliquet on the brain of *Protopterus*, where the Müllerian fibers of the Lamprey, lateral uncrossed, median uncrossed and median crossed, are all called Mauthner fibers.

metacœle causing, apparently, a slight bulge of the floor. In the region of the eighth nerve the relations are more complicated: the root of the seventh passes laterad to its exit, and the decussation of the Mauthner fibers occurs. In connection with the latter are associated many fibers of this bundle, and other finer fibers from more ventral regions. Other coarse fibers appear to pass laterad without crossing the meson. Cephalad of the seventh and eighth nerves, the size of the bundles is much reduced owing to the loss of fibers. They, with the other longitudinal myelinic tracts, gradually become separated from each other, an amyelinic area intervening (Fig. 20). Occasional decussations still occur, however, the last just caudad of the fifth, where the large fiber could be traced to the immediate neighbood of a large isolated cell, in the extreme lateral region of the oblongata. Although actual continuity was not demonstrated, it is probable from the results attained in other forms that many of the fibers which end near the level of the eighth nerve spring from the cells of the ventral region, which, as Osborn found in *Cryptobranchus*, are particularly large and numerous in that immediate neighborhood. Likewise the origin of the decussating fibers from the large, laterally situated cells near the exit of the auditory nerve, may be tentatively held.

Some of the fibers in the ventral columns pass dorsad into the cinerea in the region of the tenth (X^1) and ninth nerves, in close relation to the nidus of the seventh and the fibers of that nerve. The relations of these fibers were much clearer in *Amblystoma* than in *Necturus*, due to their closer association into a bundle in that form. Similarly, more laterally situated fibers with thick myelinic sheaths terminated in the cinerea near the exit of the eighth nerve. A comparison of these with the lateral uncrossed Müllerian fibers of *Petromyzon*, as Köppen ('88) has done for similarly situated fibers in the frog, is attractive. In addition to the above, other coarse fibers gradually migrate dorsad and laterad to lie directly ventrad of the cinerea, and terminate, a lateral group in the region of the motor nidus of the

trigeminal, a more nearly mesal group slightly cephalad of the exit of that nerve.

A comparison with the results attained by Goronowitsch in *Acipenser* shows the relations of the ventral tracts to be very similar to those set forth above. I was unable, however, to trace any of the decussating fibers in the region of the eighth into that nerve, of which in *Acipenser* he found them to constitute one of the largest components. If indeed any acustic fibers have this origin in *Necturus,* the number does not exceed three or four.

Fasciculus communis, (Osborn).—This tract has been already treated of at some length by Strong ('95) both historically and descriptively, and no extended discussion of it is needed here. In *Necturus* this tract is relatively much smaller than in *Amblystoma.* It first appears a short distance cephalad of the beginning of the metatela as a small island of ground substance in the dorsal cinerea (Fig. 11); at the exit of the first spinal nerve one or two myelinic fibers appear in it. As it increases in size, it joins the adjacent alba, from which it is but partially separated by a projection of cells dorsad of it. Up to the exit of the contingent to the tenth nerve, there are but few myelinic fibers in it. Cephalad of the exit of X^1, it is hardly distinguishable from the adjacent dorsal tracts. Between X^1 and IX it joins closely the myelinic fascicle called *tract b.* Arcuate fibers penetrate, some of which turn caudad in it; other fibers from *tract b* turn cephalad in it and possibly may be continuous with the arcuate fibers which enter it. Cephalad of the ninth it is more distinct as a separate tract and is composed almost entirely of myelinic fibers. Opposite the ninth a small fasciculus of fine fibers begins to form in the cinerea, dorso-mesad of the *fasciculus communis* which joins the bundle a short distance caudad of the seventh nerve, and with it leaves the brain to form the *fasciculus communis* component of that nerve, (VII, a. a.). I find no continuation of this bundle in *Necturus* cephalad of the seventh as it was found by Osborn ('88) in *Cryptobranchus.*

Isolated cells occur laterad and ventrad of this tract cephalad of X^1, which presumably represent what in the tadpole is

spoken of as the "so-called sensory" nidus (Strong '93). In *Necturus* the three contingents, to the seventh, ninth and tenth nerves, which leave this fasciculus are formed of fine fibers with delicate myelinic sheaths. These pass to their exit, dorsad of the ascending V, as is also the case in *Amblystoma*, differing in this respect from the condition in the tadpole (Strong '95) where they pass ventrad of it.

The homology of the *fasciculus solitarius* of man, lifted from the root bundle of X^7, has been placed by Strong upon this tract. This had been contemplated in this investigation before the appearance of Strong's work, and rejected as not capable of establishment from the facts. Although this homology is set forth by him in a most forcible and enticing manner, a hesitation is yet felt in accepting it for the following reasons: the *fasciculus solitarius* of mammals and the ascending V are regarded as entirely comparable tracts; both become medullated early; both may be traced caudad into the myel, and are accompanied throughout their course by gelatinous substance, chiefly on their mesal side, containing cells which constitute the end nidi of the tracts. (See Turner '94 and Kölliker '93). The *fasciculus communis* and ascending V in Amphibia appear to be quite different tracts. Further, by considering the *fasciculus communis* as representing the *fasciculus solitarius* alone, we leave unacounted for the larger end nidus of vagal sensory fibers. Strong apparently confounds this with the end nidus of the *fasciculus solitarius.* The strongest evidence in favor of the homology would be the exit of *fasciculus solitarius* fibers as the *pars intermedia Wrisbergii* now considered as a sensory root of the seventh, with the geniculate ganglion as its nidus of origin, which is affirmed by Kölliker ('93); by others, however, the end nidus of the glosso-pharyngeus has been stated to be the end nidus of this nerve. Brandis ('93) in speaking of the *fasciculus solitarius* in the brain of birds, stated that a portion of the fibers turned laterad to the eighth nerve and the remainder entered the trigeminal nerve.[1]

[1] A similar relation of the bundle to the fifth is also given for man by Boettiger ('90).

In a later paper, no mention is made of such relations of the solitary bundle, and he is inclined to associate the *pars intermedia* with the vago-glossopharyngeal end nidus. Further, regarding its central relations, the *fasciculus solitarius* is said in birds to decussate just caudad of the metatela,—a relation not as yet observed in man. The foregoing considerations seem to warrant postponing the acceptance of the homology until a fuller comparative study of this tract is made. Possibly the *fasciculus communis* may embody both sensory termini for vagal fibers.

Dorsal tracts.—As has already been stated, at the transition from myel to oblongata the number of myelinic fibers in the dorsal regions has greatly diminished, those remaining being almost entirely such as constitute the ascending V and X. After the beginning of the metatela, and up to the level of the first spinal nerve, these tracts occupy the extreme dorsal position in the spreading walls of the oblongata, the fibers for the tenth the more dorsal. Cephalad of this point the ascending V and X begin to migrate ventrad, leaving an amyelinic area to occupy the more dorsal portion. This area is also extended by the closer apposition of the walls of the oblongata in the region of the tenth nerve. Cephalad of X^1 the ascending V is situated in the ventro-lateral angle of the oblongata ; dorsad of it begin to be distinguished the large fibers of the eighth nerve. In this region myelinic fibers appear in the dorsal tracts, chiefly in the extreme dorsal portion and the region just dorsad of the fibers of the eighth, constituting the beginnings of the tracts named for distinction tracts *a* and *b*. Between these two tracts the region is almost entirely amyelinic with however scattered bundles of myelinic fibers. Into this intermediate area enter IX^1 and IX^2 and a portion of the "dorsal seventh" ($VIIb^2$).

Tract *a*, beginning in the region of the tenth nerve, reaches its fullest development between the seventh and ninth nerves. In the region of the seventh this tract loses its extreme dorsal position, which is here occupied by an area of amyelinic substance, apparently composed largely of 'ground substance,' into which the dorsal portion of the "dorsal seventh enters" ($VIIb^1$). This is restricted to the immediate neigh-

borhood of the seventh nerve, and cephalad tract *a* soon regains its dorsal position. Slightly cephalad of the fifth nerve it disappears, the fibers which compose it turning mesad into the neighboring cinerea. This tract does not seem to be increased to any extent from arcuate fibers.

Tract *b* likewise first appears in the region of the tenth nerve reaching its strongest development between the seventh and ninth. It lies latero-dorsad of the *fasciculus communis*. Between the ninth and tenth the tract is largely increased by arcuate fibers which turn cephalad in it. The relation of arcuate fibers to tract *b* continues throughout its length, but is most marked between the ninth and X^1. Most of the bundles which enter it turn cephalad; others, however, in the region of the ninth nerve, turn caudad; this is also the case in the region of the fifth.

Between tracts *a* and *b*, the alba is almost entirely amyelinic. Small fascicles of myelinic fibers occur, however, in it; these seem to be to a large extent arcuate fibers which penetrate this region. Fibers also pass into this intermediate region from tracts *a* and *b*. Into it enter the dorsal division of the ninth and the ventral portion of the "dorsal seventh" (IX^1 and IX^2, and $VIIb^2$).

Arcuate fibers.—Arcuate bundles are well developed in *Necturus*. In the myel fine myelinic fibers pass down from the dorsal cinerea to decussate in the raphé, assuming a longitudinal direction in the ventral columns. In the region of the 2nd spinal nerve and cephalad these fibers are greatly increased in number. Up to the exit of X^1 the number of fibers is diminished; cephalad of that point, however, they begin to pass to the dorsal tracts, traversing the alba at all levels, not confined to the border of the cinerea. Between the ninth and X^1 they largely take part in the formation of tract *b*, in which they turn both cephalad and caudad. The intermediate region between tracts *a* and *b* also receives many of them. In the region of the seventh large bundles of arcuate fibers pass dorsad to terminate in the lateral border of the cinerea adjacent to the dorsal tracts, and the dorsal island of alba into which the

dorsal portion of the "dorsal seventh" enters; and these bundles are coextensive with that area. In the region of the fifth nerve, arcuate fibers are intimately connected with the diminishing number of myelinic fibers in the dorsal tracts. Some of these seem to cross in the raphé and turn into the cinerea of the opposite side.

Origin of the Cranial Nerves. (Figs. 5, 9-20, 22.) At the time this investigation was undertaken the condition of our knowledge of the origin of the cranial nerves of the tailed *Amphibia* was far from satisfactory. Fragmentary results had been obtained by Stieda; more complete were the observations on this subject made by Osborn; still, some evident inconsistencies in his results with those reached on other forms, and a failure to recognized the true relations of certain nerves, rendered a review of the subject desirable. In respect to the homology of the nerve components, as stated by him, interpretations depended largely on the peripheral relations and distributions of the several components, of which nothing satisfactory was known. The papers of Strong, however, have supplied the necessary information; not only has he investigated the distribution and segmental value of the components but also made extensive comparisons with the cranial nerves of other *Ichthyopsida*. The ental or deep origins have also been discussed by him, rendering less necessary an extended description here; however, as the results here attained confirm, and in part supplement his, they are, in so far, at least, of value and will be given. Where possible, the roots in *Necturus* have received the names applied by him. Instead of the terms *motor* and *sensory nuclei* or *nidi*, the recent results of the impregnation methods render preferable a terminology in which the relations of fiber and cell are more distinctly implied, and here will be employed those adopted by Kölliker ('93) ("Endkern" and "Ursprungskern") and Turner ('94), "nucleus of origin" and "terminal nucleus" *nidus* being employed in preference to *nucleus*. It is evident that the nidus of origin of sensory nerves would be the peripheral ganglia from the cells of which their fibers spring, and the 'terminal nidus' within the brain, with which they

have physiologic connection, might be the nidus of origin of some intra-cerebral tract or tracts, &c.

In *Necturus*, the cranial nerves generally found in Amphibia are present. The difficulties in the recognition of the eleventh and twelfth nerves have already been spoken of. The two motor roots rising from the ventral columns caudad of the tenth (X^7) have been termed the 1st and 2nd spinal nerves, despite the fact that they have no dorsal roots or ganglia.[1] Their mode of origin within the brain is that shown by Stieda for the motor roots of the spinal nerves in the Axolotl; some of the fibers pass directly dorsad to the ventral horns, a larger number turn cephalad in the ventral tracts, others caudad. No special nidus or origin for either of the nerves was recognized.

Vagus.—This nerve and the glossopharyngeal are closely related to each other. The vagus arises by two roots which are formed in *Necturus* of seven minor rootlets, of which the two caudal unite to form one root, the eleventh of some writers, the cephalic five forming the tenth. X^1, the largest, arises from the lateral aspect of the oblongata and derives its fibers from two sources,[2] (1) the *fasciculus communis*, whose fibers leave the brain the more dorsally, (2) ascending fibers, chiefly of large caliber, which migrate ventrad into the ascending V. Some of these fibers may be traced caudad as far as the exit of the 2nd spinal nerve. Burckhardt has found in *Protopterus* a decussation of similar ascending fibers of the tenth caudad of the metatela. In *Necturus* a decussation of small fibers was observed in this region but their relation to the tenth nerve could not be determined. Strong speaks of this component in the tadpole as derived from the ascending V. In *Necturus* they

---

[1] Even in man, Gray (Anatomy, Descriptive and Surgical) states that the dorsal root of the first spinal nerve is much smaller than the others and frequently has no ganglion.

[2] The true physiologic direction of the fibers is for convenience of description disregarded here, thus though really the impulse is "descending," the old term, *ascending V* is retained.

appeared rather to arise dorsad to the fibers of the ascending V and to migrate ventrad into that tract toward their exit. There seems to be no representative of these fibers in "fishes," nor, indeed in higher forms, unless it might be represented by the *fasciculus solitarius*, a rather unsafe comparison though there is a resemblance in the comparability of these with the fibers of the ascending V. The decussation of certain fibers of this component in *Protopterus*, in view of a similar decussation of the solitary bundle observed in birds, is suggestive. The fibers from the *fasciculus communis* are fine, with delicate myelin sheaths, as are all fibers derived from this tract.

X^2 and X^3, which are very delicate and of few fibers each, are undoubtedly motor, arising farther ventrad from the region of large motor cells.

X^4 and X^5 arise slightly caudad to the three rootlets above, and are very close to each other. X^4 is probably sensory and its fibers like a portion of those of X^1 accompany the ascending V.

Roots X^5, X^6 and undoubtedly X^7 are motor, and arise in much the same manner. The root fibers of the most caudal of these roots (X^7) may be recognized as far caudad as the caudal end of the metatela, and form an ascending fasciculus in the lateral columns of the oblongata adjoining the cinerea. Osborn regarded this ascending bundle as the representative of the solitary bundle of the mammalian brain, but erroneously, as was pointed out by Strong. The entire bundle turns directly laterad to constitute X^7. Near the exit of this root fibers appear in the adjacent cinerea among the motor cells and unite to form a fasciculus occupying the same position as did the fibers of X^7. The fibers leave the brain as X^6 which joins X^7, forming the major root sometimes spoken of as the eleventh nerve. In addition to its ascending fibers, a few entered root X^7 which came from the region of the ascending V and were presumably sensory. In precisely the same manner as X^6 arose X^5 which was however closely related to the roots cephalad of it.

The following Table may summarize what has been said above concerning the roots of the tenth nerve and their origin :

VAGUS NERVE.

roots.	*size.*	*source.*	*character of fibers.*	*function.*
X 1	large	fasc. com.	fibers fine	
		asc. tract.	fibers coarse.	sensory.
X 2	small	motor nidus	medium.	motor.
X 3	small	" "	"	"
X 4	medium	asc. tract.	"	sensory.
X 5	small	motor nidus.	"	motor.
X 6	medium	" "	"	"
X 7	medium	asc. lat. tract.	"	motor ?
		asc. tract (few)	"	sensory.

As compared with the origin in *Cryptobranchus* as set forth by Osborn, the following differences may be noted: his solitary bundle enters two roots in *Cryptobranchus*, but one in *Necturus*. The *fasciculus communis* enters two roots, one in *Necturus*. Further, no ascending sensory root in addition to the *fasciculus communis* was found by him; in *Necturus* it enters three roots though in two of them the contingent was small.

Strong's results on the tadpole show slight differences, the most important of which is the changed relation of the *fasciculus communis* and (his) ascending V components, the first being ventral in the tadpole, dorsal in *Necturus*. There seem to be fewer roots, three only being recognized by him, the first drawing its fibers from the *fasciculus communis*, ascending tract (his ascending V) and a motor nidus; the second, *fasciculus communis* and a motor nidus; the third, ascending lateral tract (solitary bundle of Osborn). The differences in the relation of the *fasciculus communis* should be noted. As to whether the ascending fibers of the tenth nerve can be said to be derived from the ascending V is merely a matter of definition; they are, indeed, closely associated with that tract.

Glossopharyngeus.—This is closely related to the vagus, and possibly would have been better discussed with it. What are treated here under this name include the ninth nerve proper, and, from the researches of Strong, the representative of the "*Ramus lateralis vagi*," or "*Nervus lateralis*" of other *Ichthyopsida.*

The nerve is distinct from the vagus almost up to its gang-

lions, which are fused with those of the vagus. Near the brain, however, it turns cephalad, and soon divides into two bundles, IX^{1+2} and IX^{3+4}. The first is the 1st Vago-glossopharyngeal root of Strong, (IX^1 of Osborn), and the representative of the lateral line nerve of fishes (Strong); IX^{3+4} is IX^{2+3} of Osborn, 2nd root of Strong.

IX^{3+4} is the more caudal and is formed of two roots. The *fasciculus communis* gives off a large contingent to form IX^3; it passes dorsad to the ascending fibers of the eighth. IX^4 springs from the motor cells in the floor of the oblongata and passes ventrad of the ascending fibers of the auditory, to its exit, joining IX^3 immediately. There is an exact agreement in the above with the results of Osborn and Strong.

The other division is composed of fibers of a very characteristic and constant appearance. They are large, with very dense myelinic sheaths, and are of the same appearance in all the forms studied. This bundle proceeds cephalad a short distance and enters the dorsal region between the tracts here called *a* and *b*, by two roots, one more dorsal and slightly cephalad of the other, and separated from it by a small fasciculus of longitudinal fibers. Some of the fibers of each root lose their myelin almost immediately on entering the brain and disappear; others may be traced cephalad for a few sections, but are lost within a quarter of a millimeter from the point of entrance. None of the fibers were observed to turn caudad within the brain.

The region into which these roots enter contains but small scattered bundles of myelinic fibers, of which the largest, on the ectal surface of the brain, separates the two roots. An interchange of fibers occurs immediately cephalad of the roots. Many arcuate fibers go to the dorsal tracts at this level. The cinerea that adjoins the dorsal tracts at and cephalad of the entrance of this nerve is composed of small cells and must be regarded as the terminal nidus.

An extensive comparative discussion of this nerve is given by Strong ('95). The lateral branch of the vagus, or more correctly perhaps the lateral nerve, has been likewise found to arise

cephalad of the ninth nerve in *Acipenser* (Goronowitsch), the *Cyprinidæ* (Mayser), sharks and Rays (*Læmargus*, *Lamna*, *Raia*) (Ewart), and *Galeocerdo* (Strong, '95), and Wright was inclined to regard its origin similar in *Amiurus*. In the *Cyprinidæ* the fibers were derived from the *tuberculum acusticum*. In *Acipenser* Goronowitsch found the lateral nerve formed of ascending and descending fibers from the "dorso-lateral" tract, of which the descending bundle was much the larger and was thought by him to come from the cerebellum. In *Necturus* the origin of these fibers was restricted to the dorsal region of the oblongata in the region caudad of the eighth nerve, which might be regarded as representing the *tuberculum acusticum* of the teleosts, although no *tuberculum acusticum* proper exists. Certainly no fibers can be traced cephalad to the cerebellum.

In *Necturus*, as compared with the other urodeles examined, this nerve was greatly developed, a condition to be expected, both from its larger size and the greater number of sense organs in *Necturus*. The ratio of IX^{1+2} to IX^{3+4} in this form is approximately 2:1. In *Amblystoma*, both roots, IX^1 and IX^2 are distinct but their ratio to IX^{3+4} is about 1:1.

Acustic Nerve.—As far caudad as the exit of the X^1 large fibers begin to appear in the region dorsad to the ascending V and between it and tract *b*. These increase in number cephalad, and at last, about 1 millimeter cephalad of the entrance of IX^1 they enter the eighth nerve. This forms a considerable and indeed the largest source of the fibers of the eighth nerve. The fibers are large with thin myelinic sheaths and are very easily traced. A far smaller portion of the acustic fibers, which are also of finer caliber, turn cephalad. Osborn ('88) regarded such in *Cryptobranchus* as decussating through the cerebellum with the corresponding fibers of the eighth nerve on the opposite side. A direct relation of acustic fibers to the cerebellum in the lower forms appears probable from the results of Mayser, Goronowitsch, and Köppen, ('88) on the species investigated by them. Ahlborn however considered that the fibers entering the cerebellum in *Petromyzon* were commissural between the acustic nidi of the two sides. In higher forms the

direct relation of acustic fibers (of the vestibular nerve) to the cerebellum, is stated by Edinger, ('86) Sala and Brandis, but disputed by Kölliker. An ascending root of the eighth nerve is recognized by Goronowitsch, and by Stieda in the *Axolotl*.

In addition to the fibers spoken of above, others seem to end almost immediately on entering the brain, in close proximity to large cells situated in the lateral region, which have been likened to the large cells in *Petromyzon* connected with the median crossed and lateral uncrossed Müllerian fibers. Similar cells occur caudad as far as IX^1 and may possibly represent, or be closely connected with the terminal nidus for the ascending acustic fibers. Osborn suggests a comparison of these with Deiter's nidus of mammals. But a single acustic root was observed in *Necturus*. This is contrary to certain theories of the development of the ear and with results in some other, especially higher forms; it agrees however with the condition found in *Cryptobranchus* and the *Axolotl* (Steida '75). Possibly the two roots may be represented by the ascending and descending fibers. The eighth is $VIII^2$ of Osborn in *Cryptobranchus*. The correspondence between the two forms would seem to be close, though his figures leave much to be desired. The relation to the large cells is noted by him, and ascending and descending fibers, though the ascending tract apparently does not have as great extent as in *Necturus*. The derivation of the descending fibers from the mesencephal after decussation in the cerebellum, must seem doubtful from the relations found elsewhere.

Facial Nerve.—This nerve is formed of two components, VII*aa*, a sensory root from the *fasciculus communis* of Osborn, and VII*ab*, motor, formed by two, or in some cases three, rootlets, arising from the oblongata ventrad of and at about the same transverse plane as the eighth.

VII*ab*.—At about the exit of the tenth (X^1) nerve, myelinic fibers begin to appear in the cinerea dorsad of a nidus of large cells in the ventro-lateral portion of the floor. From here to slightly cephalad of IX^1, fibers spring continuously from this region and unite to form a close bundle which passes mesad to lie dorsad of the posterior longitudinal bundle and immediately

ectad of the endyma, causing a slight elevation. In this position they run cephalad to just caudad of the exit of the eighth where they turn laterad and ventrad, in two (or three) bundles, to leave the oblongata as the motor roots of the seventh nerve, and immediately unite with the issuing fibers of the eighth. The origin of these roots in urodeles, and the recognition of them as homologous with the facial of higher forms, have been involved in a great deal of obscurity. Stieda ('75, p. 302) recognized this bundle in the floor of the oblongata as belonging to the facial and describes its exit to form that nerve; he could not, however, discover the origin. Osborn ('88), in his study of the oblongata of *Cryptobranchus*, regarded this as belonging to the eighth instead of the seventh, and derived the fibers of VII*ab* from the posterior longitudinal fasciculus. He was not, however, certain of the correctness of the homology, and in note 3 in the appendix to his paper, seemed inclined to doubt the relation of the fibers to the posterior longitudinal bundle. He was influenced in his view of this tract by the close relation of the posterior longitudinal fasciculus and the eighth nerve in the papers of Fulliquet and Ahlborn, the last of whom his misquotes, however. The ventral division of what is here termed the dorsal VII was considered by him motor and to represent the root which would otherwise be wanting. Burckhardt ('91) following Osborn, named these roots, VIII, 3 and 4, and found them composed "mostly of Müllerian fibers." He also regarded the ventral root of the "dorsal seventh" as representing the facial. His VIII, 3 and 4 in *Protopterus* ('92) are the same, and these he derives "in part from the posterior longitudinal fasciculus, and in part from a motor nidus." Strong did not attempt a solution of the question but regarded the source of these fibers as partly from the posterior longitudinal fasiculus and partly from the trigeminal motor nidus.

In view of the importance of the matter, and the confusion with regard to this nerve in Amphibia, a somewhat extended comparative discussion seems desirable; especially since the mode of origin of this nerve is so nearly constant in widely

different forms. It is scarcely necessary to point out the exact comparability between the modes of origin of the facial nerve in Amphibia[1] and man. The nidus is situated rather deeply and begins to appear in sections just caudad of the pons. From this, fibers arise which associate themselves into a bundle upon the dorsal side of the posterior longitudinal fasciculus, in which position they run cephalad to turn sharply laterad and ventrad to their exit as the facial nerve, the two bendings constituting the well known "knee of the facial" (*genu nervi facialis*).

In his studies of the brain of teleosts, Mayser has investigated the oblongata and the origin of the nerves to a considerable extent. He describes the mode of origin of the seventh in the following words: "Die grobfaserige ventrale gekniete Quintuswurzel (*N. V. gen. vent.* [*VII*] kennt Stieda (p. 35 and 55, Knochenfische) und Fritsch (a. a. O. p. 85). Die Wurzel bildet sich bei Cyprinoiden aus zwei hinter einander entspringenden Bündeln. Das hintere legt sich der Aussenseite der aufsteigenden motorischen Vaguswurzel (*N. IX. mot.*) an und kommt aus dem hinteren Trigeminuskern Stieda's und einer Ansammlung sehr grosser blasenförmiger Zellen, welche zwischen den Kommissurenfaserzügen und zu beiden Seiten des hinteren Längsbündels liegen (*Nuc. N. V. gen. vent. post.*, Fig. 27); das vordere entspringt in derselben Weise da, wo die aufsteigende motorische Vaguswurzel (*N. IX. mot.*) nach aussen umbiegt (*Nuc. N. V. gen. vent. ant.*, Fig. 29). Vereinigt ziehen beide, fast nur vom Epithel des Centralkanale bedeckt und mit dem hinteren Längsbündel aussen oben innig verbunden nach vorn, biegen etwas vor der Umbeugungsstelle der dorsalen Kniewurzel plötzlich unter rechtem Winkel nach aussen um, wobei sie den *N. V. asc.* und die vordersten Partien der vor-

---

[1] In the frog, if we may trust the observations of Stieda and Köppen, the mode of origin of the motor fibers differs entirely from that commonly found, the fibers entering the nerve directly from the trigeminal motor nidus. I find the mode of origin of this nerve in *Amblystoma* and *Diemyctylus* as described above in *Necturus*.

deren Acusticuswurzel (*N. VIII. ant.*) durchbrechen (Fig. 27-31)." No commentary is necessary upon the above. In Wright's paper upon the brain of *Amiurus,* although no attempt at tracing the internal origin of the nerves is made, it is evident from his words and figures that the larger portion of the facial fibers arise in much the same manner as set forth by Mayser. A portion of the fibers he derived from a nidus near the nerve (p. 360.).

In *Acipenser* is found precisely the same mode of origin, as may be seen from the two paragraphs below in which the origin of the facial nerve in that genus is described. The comparison with *Necturus* is close. I did not however, find any fibers of the facial to be derived from the ventral columns. It is still possible that some of the fibers before mentioned as terminating at or near the facial nidus, may pass directly into the root bundle of the facial nerve. Goronowitsch has been misquoted as to the origin he found for the facial nerve, and it has seemed best therefore to reproduce entire the portion in which it is described by him. "Proximal von der Austtrittsstelle der *N. lineae lateralis* gesellt sich zu den Bündeln ein anderes Längsfasersystem (Taf. XX, Fig. 49, *Frv.*) Die fasern desselben kommen aus der grauen Substanz des Vorderhornes, sowie aus den Ventral liegenden Theilen der weissen Substanz (Taf. XXII, Fig. 81 *Frv.*). Diese Fasern umkreisen den Boden der Vorderhirnrinne und steigen, der seitlichen Oberfläche der hinteren Längsbündel folgend, in die dorsalen Abschnitte dieser letzeren, wo sie einen runden Strang bilden. Es sind, wie wir gleich sehen werden, die Fasern der ventralen Wurzel des Facialis. Mitunter findet man, dass die Fortsätze der motorischen Zellen bis zu den Fasern des Facialis zu verfolgen sind. (Fig. 81). Ein kleiner Theil der Fasern kommt, wie gesagt, aus den ventralen Abschnitten der weissen Substanz. In den betreffenden Querschnittsebenen der Oblongata enthält die weisse Substanz viele zerstreute grosse Ganglienzellen. Ob diese Zellen als Ursprungsstätten eines Theiles der Fasern des Facialis aufzufassen sind, konnte ich nicht sicher entschei-

den. Einige Fortsätze wenden sich in der Richtung der Fasern. Alle diese Verhältnisse sind in Fig. 81. dargestellt.

"Die Fasern der ventralen Wurzel des Facialis sind etwas feiner als die der hinteren Längsbündel und sind daher sehr leicht in proximaler Richtung zu verfolgen. In der Nähe der Austrittsstelle koncentrirt sich der Faserzug in einen kompakten runden Strang, welcher einen Vorsprung auf der dorsolateralen Oberfläche der hinteren Längsbündel bildet. Der Strang biegt lateral unter rechtem Winkel um und durchzieht, bogenförmig und ventralwärts verlaufend, den proximalen Theil der austretenden Acusticusfasern (Taf. XX Fig. 50 *Frv.*) Vor der Austrittsstelle dieses letzeren Nerven tritt die Wurzel aus und legt sich eng ventral an die dickere dorsale Wurzel des Facialis an. (*Frd.*) Ein Theil der queren Bahn der ventralen Wurzel bildet die makroskopisch wahrnehmbaren Abzweigungen der hinteren Längsbündel, welche ich im anatomischen Abschnitte besprochen habe."

In turtles, judging from the figure of Humphrey ('94), a portion of the fibers, at least would seem to be associated with the posterior longitudinal bundle. In birds Brandis has found the same origin as in mammals, with, however, the middle portion, (ascending limb) reduced to a minimum.

In Elasmobranchs, the origin of a motor portion of the facial is obscure; Rohon's statements of the origin of the facial are too vague and indefinite to admit of any conclusions being founded upon them. Sanders has found the facial to spring from the bundle called by Rohon *fasciculus longitudinalis lateralis*, (comparable with *fasciculus communis* ?), and it would seem to be a sensory root. Indeed, Jackson and Clark in speaking of the peripheral distribution of the facial in Elasmobranchs, state that the muscles innervated by the seventh in teleosts do not exist in Elasmobranchs and that therefore a motor portion is absent. Equally unsatisfactory is the state of knowledge of this nerve in *Petromyzon*. Ahlborn describes the facial as arising by a single root from a nidus dorsad to the acustic nidus. The cells in the nidus are small and the issuing fibers fine. By Julin and Dohrn the facialis in *Petromyzon* is

asserted to contain motor elements (Strong '95), in which case we should expect to find another origin for a portion of the fibers.

VII*aa*, is small and arises at the level of the eighth nerve and dorsad of it, from the *fasciculus communis* and a small accessory bundle of fibers which springs from the cinerea mesodorsad of the *fasciculus communis*. The fibers are small and lightly medullated. On their way to the periphery they penetrate tract *b*, which is well developed at this level. The ganglion of this contingent is fused with that of the eighth, and represents probably the geniculate ganglion, the nerve itself representing the *pars intermedia* (Strong). Strong finds that the palatine nerve is formed by this component of the seventh. In *Necturus*, as indeed in other urodeles, this nerve (palatine) does not, as in the Anura, come into relation with the Gasserian ganglion.

Dorsal VII.—This is the VII u and l, of Osborn; VIIb or Dorsal VII of Strong. The fibers of which it is composed differ greatly in appearance from the other fibers of the facial, and indeed the other cranial nerves except IX^{1+2} with which they correspond exactly. The figures show them very inadequately; they are large and with dense myelinic sheaths. In *Necturus* the roots unite to form the dorsal seventh, and they are here spoken of as $VIIb^1$ and $VIIb^2$, VII^1 rising dorsad and slightly caudad from a region well demarcated from it. At about one-third of the distance (going cephalad) between IX^1 and VIII there begins to be formed in the extreme dorsal portion of the dorsal tracts an area of amyelinic substance of a structureless appearance—ground substance. This increases in amount to the region of the eighth nerve and decreases again cephalad of this point, disappearing entirely half a millimeter cephalad of that nerve. Into this island resting upon tract *a*, $VIIb^1$ enters at the level of the eighth. The fibers lose their myelin immediately on their entrance and disappear, turning neither cephalad or caudad. The cells immediately adjoining this area undoubtedly represent the terminal nidus of this root.

$VIIb^2$ enters the same portion of the dorsal tracts as does

IX^{1+2}; that is, the region between tracts *a* and *b*, separated therefore from $VIIb^1$ by tract *a*. Some of the fibers appear to terminate immediately; most of them, however, turn caudad and may be readily followed for but a short distance, since they soon lose their myelin, and become indistinguishable; some even as amyelinic fibers may be followed for a short distance farther, that is to a little caudad of the exit of the eighth nerve.

$VIIb^1$ and $VIIb^2$ unite immediately to form VIIb which soon divides into two approximately equal portions, one of which joins the motor and *fasciculus communis* portions of the seventh and the eighth nerve, while the other division goes cephalad to the Gasserian ganglion.

The close comparison in origin between IX^{1+2} and $VIIb^2$ is evident: both end in approximately the same region caudad of the eighth; the fibers of IX^{1+2} turning cephalad to it, those of $VIIb^2$ caudad to it. The difference in origin between $VIIb^2$ and and $VIIb^1$, though slight, might seem to indicate that the two roots were different; that $VIIb^1$ passed to the Gasserian ganglion and should be considered as belonging to the fifth proper, as was interpreted by Herrick ('94), and representing perhaps the dorsal root of Trigeminus II of Goronowitsch in *Acipenser*. This does not seem to be the case however; the fibers of both roots are of the same size and appearance; further, the division between the roots is not the the division between the portions which join the fifth and seventh, a portion of the $VIIb^1$ undoubtedly joining the seventh and eighth. In smaller forms, *e. g.*, *Amblystoma* and *Diemyctylus*, a division into two roots is less marked, due partly to the weaker development of a tract separating them.[1]

---

[1] Pinkus, '95, has examined the larvæ of *Salamandra maculosa* and *atra*, *Desmognathus fusca* and *Salamandrina*, and recognized in all the lateral line root of the VII (VIIb of Strong). In the adult of *Salamandra atra* and *Geotriton fuscus* the lateral line nerves are absent, although in the first genus a delicate strand pasess from the seventh nerve to the Gasserian ganglion and at that point atrophies. I have examined in this connection the brains of adult forms of *Amblystoma punctatum*, *Diemyctylus viridescens*, *Desmognathus fusca* and *Plethodon erythronotus*. In the first three genera the lateral nerve roots of the VII were present, although in *Desmognathus* the bundle to the Gasserian ganglion was

In fine, in *Amphibia*, the "dorsal VII" and "dorsal IX" (IX^{1+2}), both terminate in the dorsal region of the oblongata, in the immediate neighborhood of the eighth nerve and in large part slightly caudad of it.

Abducens Nerve.—This is very small in *Necturus* and arises from the ventral aspect of the oblongata by two very small roots. I was unable to trace it to its nidus. In *Amblystoma*, though the nerve is much larger and arises by three roots, no direct relation to a nidus could be observed. The fibers sprang apparently from the posterior longitudinal fasciculus. Undoubtedly the motor cells of the ventral region in this immediate neighborhood constitute the nidus of origin.

Trigeminus.—The fifth nerve is the largest of the nerves arising from the oblongata; and, save the olfactory, of all the cranial nerves. The fibers of which it is composed are drawn from four sources, and leave the brain by three ill-defined roots.

(1). Ascending V. This furnishes by far the largest portion of the fibers of the fifth in *Necturus*. It can first be distinctly recognized in the myel a slight distance caudad of the second spinal nerve, where it occupies a dorso-lateral position. In this region it is small. At the level of the first spinal nerve, it has increased in size and from this point cephalad begins to migrate ventrad. At the level of X^1 its position is lateral and the fibers of the tenth pass through it. At the eighth it is ventro-lateral, the eighth arising dorsad of it. Its fibers are mostly small, although a considerable number of large ones occur in it, some of which can be traced from its first appearance in the caudal portion of the myel. No augmentation by fibers from motor nidi was observed, and it is presumably purely sensory.

(2). Sensory nidus (terminal). Cephalad of the exit of the dorsal seventh, fibers arise among the cells adjoining the

---

very small. In *Plethodon* no trace of it was found and the roots of the lateral line nerves are believed to be absent. Pinkus did not examine the ental origin of the lateral line roots in *Protopterus*, but the ectal relations shown by him and the results of Burckhardt ('91) indicate a close resemblance to the conditions in the Amphibia.

ascending V, which associate themselves with that tract near the exit of the nerve. The cells among which these fibers appear presumably represent a terminal nidus, the sensory nidus of Osborn. Its extent in *Necturus* is much less however than in *Cryptobranchus*.

(3). Motor nidus. A short distance cephalad of the level shown in Fig. 19 the motor nidus of the fifth nerve appears in the floor of the metencephal, succeeding, but entirely separated from the nidus of the seventh, compared with which it is much more compact. It extends cephalad to the exit of the nerve. From this two bundles of fibers pass down to constitute the smaller roots of the fifth, V^{2+3}, which however, fuse immediately with the larger root.

(4). From the Mesencephal. As stated by Osborn, the large ganglion cells in the roof of the mesencephal which constitute the mesencephalic trigeminal nidus, are quite numerous in *Necturus*. They are found scattered throughout the extent of the roof but are massed more closely just cephalad of the cerebellum, as described by Osborn (Fig. 22). From this nidus large fibers spring which pass caudad grouping themselves in two divisions, one of which enters and passes ventrad through the cerebellum; most of these fibers enter the large root (V^1) of the nerve. Others pass the fifth without entering it, as noted by Osborn, and may be traced caudad, meso-dorsad of the ascending V, to the neighborhood of the seventh and eighth nerves.

The two smaller roots of the trigeminal are evidently not entirely the same as the motor root of man, inasmuch as from the latest evidence the mesencephalic descending tract enters the smaller motor root in man. Nor, indeed, would V^2 and V^3 in *Necturus* be the same as the rootlets in *Cryptobranchus*, which Osborn found to be formed by the descending tract.

I, II, III, and IV.—The remaining cranial nerves have received but superficial attention, and little more can be said of them than that their origins seem to be as described in other *Amphibia*.

The trochlearis (IV) is very small in *Necturus*, and I failed

utterly to trace the fibers to their nidus of origin in the base of the brain. The distribution of a portion at least of the fibers to the metaplexus has been noted before; nothing in the character of a terminal nidus was observed.

The oculomotor (III) enters the brain at the level of the mesencephalic pit and passes dorsad to its nidus in close relation to the posterior longitudinal fasciculus. Several large ganglion cells occur cephalad of this point at about the region of transition from mesencephal to diencephal, which Osborn regarded as constituting a portion of the oculomotor nidus, and also as having a relation to the fibers of the postcommissure. With Burckhardt, however, I must consider the relation of these cells to the post-commissure as of no significance, and regard as doubtful any direct connection of these with oculomotor fibers.

The undeveloped condition of the optic nerves has been commented on. The decussation of the fibers appears complete, the fibers all proceeding dorsad and caudad upon the ectal surface of the brain to the mesencephal.

The cranial nerves of Necturus cephalad of the tenth that have been more especially studied may be tabulated as follows:

nerve.	*roots.*	*size.*	*source.*	*character of fibers.*	*function.**
Fifth	V^1	large	ascending V	fine and coarse	sensory.
			mesencephal	coarse	motor (?).
			sensory (terminal) nidus	fine	sensory.
	V^2+V^3	small	motor nidus	medium	motor.
Sixth	VI (2 roots)	small	———	medium	motor.
Seventh	VIIab.	medium	motor nidus	medium	motor.
	VIIaa.	small	fasc. communis	fine	sensory.
Eighth	VIII.	large	asc. fibers	coarse	sensory
			desc. fibers	fine	
			adjacent cinerea	———	
"Dorsal" Seventh	$VIIb^1$	medium	dorsal 'Island'	coarse	sensory.
		medium	dorsal tract	coarse	
Glosso-pharyngeus	IX	medium	fasc. communis	fine	sensory.
	IX	medium	motor nidus	medium	motor.
"Dorsal"	IX	medium	dorsal tracts	coarse	sensory.
Ninth	IX	medium	dorsal tracts	coarse	sensory.

*This, of course, is only stated inferentially, since no experiments have been made to determine it empirically. In general, those roots springing from

FIBER TRACTS.

It seems best to collect under this head disconnected observations that have been made on the fiber relations in various parts of the brain, and which, due to inadequate study of the structure of related parts must be treated separately.

Lemniscus.—As far caudad in the oblongata as the exit of the tenth nerve (X^1) a denser arrangement of some of the fine fibers in the ventral region of the oblongata is apparent. This becomes more marked at the ninth and in the region of the eighth a more or less distinct bundle is formed in the alba (Fig. 17) midway between the meson and lateral aspect. This gradually becomes more marked and migrated laterad to pass dorsad into the mesencephal and there become lost. It is shown in the figures 15-17; 19-21; and 35. A large portion of the fibers which form this this tract in the oblongata cross in the raphé, and undoubtedly come from the dorsal regions as arcuate fibers, as may be seen from horizontal sections. This presumably represents the lemniscus or a portion of it as Herrick has already stated. It appears to be much better developed, as a myelinic tract at least, in *Necturus*, than in *Amblystoma* or *Diemyctylus*.

Posterior longitudinal fasciculus (*Fasciculus longitudinalis dorsalis*, Hintere Längsbündel).—The course and relations of the fibers of this tract in the caudal portion of the oblongata have been already described. Cephalad of the fifth nerve the tracts are represented by a few coarse fibers with which are associated finer ones. Just caudad of the mesencephalic pit other longitudinal fibers decussate and become closely associated with these bundles. Slightly cephalad of the exit of the third nerve, this tract is no longer recognizable; its disappearance in

---

the ventral region of the oblongata are motor, those arising from the dorsal portion and having relation to small-celled nidi are considered sensory. There would seem to be no doubt of the correctness of the function ascribed, since it is confirmed by the study of the distribution of the nerves, and, in the case of certain of them (e. g., fifth and seventh) in which the ental origin is much as in higher forms, a double confirmation can be had.

the immediate neighborhood of the large cells in this region,—the second oculomotor nidus of Osborn,—is suggestive.

Cerebellum.—The structure of this may be reviewed here. It is very rudimentary indeed in *Necturus*, consisting simply of fibers in two groups, as described by Osborn for *Cryptobranchus*; *coarse* fibers which pass up from the oblongata and turn into the mesencephal on each side of the meson; *fine* fibers, some of which turn caudad into the metencephal, and some cephalad into the mesencephal,—thought by Osborn to be decussating tracts from the auditory nerve. The rudimentary condition of the cerebellum did not permit me to recognize the prepeduncles[1] (Bindearme), which are present in other Amphibia, and decussate cephalad of the mesencephalic pit (Burckhardt, '91).

Postcommissure.—This is well developed. Its fibers are readily followed toward the base of the brain, but soon become dispersed, some of them appearing to assume a caudal direction. Köppen ('88) states that in the frog they end in the cinerea dorsad of the *pars peduncularis.*

Meynert's bundle is a close though small tract in *Necturus*. It arises in the region of the habenas and passes caudo-ventrad to the ectal surface of the base of the brain, where it becomes diffuse, but may be traced caudad to the mesencephalic pit. Considerable obscurity has existed concerning the relations of this tract in lower forms. It is generally described as terminating in the interpeduncular ganglion; Ahlborn however, stated that in *Petromyzon* it might be traced into the oblongata; Osborn ('88) traced it slightly caudad of the interpeduncular nidus in *Cryptobranchus*, while Burckhardt ('91) has apparently recognized two tracts in *Protopterus*, a *fasciculus retroflexus* terminating at the ganglion interpedunculare, and a Meynert's bundle entering the oblongata. The recent application of the Golgi method by Gehuchten ('94) to this problem (in the trout) has shown that the fibers of Meynert's bundle spring from cells in the habenas and terminate in end-brushes in intimate relation to the cells of the interpeduncular nidus.

---

[1] Herrick has called these in the frog medipeduncles. In the absence of a pons this interpretation seems to me erroneous.

Supracommissure.—This is but weakly developed in *Necturus*. As described by Herrick it consists of two bundles, a cephalic larger and a caudal smaller which cross the meson independently. Whether or not the smaller one could be regarded as a *commissura habenarum* could not be determined since the two parts of the commissure joined farther laterad. In addition to a small contingent which seemed to pass ventrad into the thalamus, this tract passed ventro-laterad into the lateral wall of the cerebrum. (Fig. 28.)

Another small number of fibers, a few of them medullated, passed down from the region of the habenas into the mesal wall of the cerebrum. They did not however, seem to come from the supracommissure.

Ventral commissures.—Considerable difficulty attends the homology of the fibers which cross in the floor of the diencephal and mesencephal. Caudad and cephalad of the mesencephalic pit myelinic fibers cross the meson; those caudad are decussational, while those cephalad seemed to be decussational in part and may be, I am inclined to believe, regarded as representing the *commissura ansulata* of teleosts.

Caudad of the optic chiasma an extensive crossing of fibers occurs, the larger portion of which, at least, are myelinic, in which Herrick has attempted to find the representatives of the commissures of the teleostean brain. The larger portion of the fibers turn dorsad and then caudad to reach the mesencephal, the *commissura transversa* (*Decussatio transversa*, Edinger). I cannot agree with Herrick in the recognition of a *commissura horizontalis*; what he figures and describes as such in *Necturus*, I find to be amyelinic bundles from the thalamus which join the basal prosencephalic tract. However, I agree with him in being unable to find any trace of the "Mantelbündel" of Edinger; a few only of the fibers which cross caudad to the chiasma turn cephalad and suggest a possible homology.

Precommissure.—This has already been mentioned in the discussion of the question of callosum. Fibers which cross in this commissure turn, some cephalad, and some caudad, representing presumably the *pars olfactoria* and *pars temporalis* of the

precommissure of higher forms. Numbers of myelinic fibers from the basal prosencephalic tracts decussate in it and also dorsad to it. Immediately above it is the callosum of Osborn, here called for distinction 'dorsal commissure.'

Basal Prosencephalic Tract.—As has been stated by Fish ('95), the fiber bundle thus designated has received various names. Of these the term applied by Edinger, 'Basale Vorderhirnbündel' seems to the writer most appropriate and the English equivalent employed by Osborn, 'basal prosencephalic tract' (*b. p. t.* of the figures) is used. The term "peduncle" employed by Herrick and Fish is misleading since these tracts are not the equivalent of the *pedunculi cerebri*, or *crura*. Were there no false homology implied, the term peduncle would still be objectionable because of the possible confusion with the peduncles of the cerebellum.

Edinger ('93, p. 31) speaks as follows of this tract: "Das Vorderhirn der Knochenfische besitzt an der Basis ein mächtiges Stammganglion, *Corpus Striatum*, ... Das Stammganglion ändert nun von den Fischen bis hinauf zum Menschen seine Lage und sein relatives Grossenverhältniss nicht mehr wesentlich. Am gleichen Orte finden wir überall die gleichgebaute Anhäufung von Ganglionzellen, überall entspringt aus ihr ein machtiges Faserbündel, das sich caudalwärts wendet und immer in Ganglien des Zwischen- und Mittelhirn sich auflöst. Es heisst basales Vorderhirnbündel und ist für Säuger seit Langem als Linsenkernfaserung bekannt." On pages 93 and 94 is given a further discussion of the representative of this bundle in the mammalian brain.

In *Necturus* these tracts may be recognized first in the caudal portion of the diencephal where the fibers which form them are rather diffuse. Farther cephalad it is augmented by several bundles of amyelinic fibers which come from the thalamus (Fig. 23) and at the level of the optic nerve it has become a well marked round bundle (Fig. 28) containing both myelinic and amyelinic fibers. Apparently few fibers come from the mesencephal, none farther caudad; a small portion also seems to come from the infundibular region. It passes into the latero-

ventral wall of the cerebrum, which has been homologized with the striatum, and there most of its fibers terminate. Some of the fibers decussate in the precommissure as before mentioned, and a number extend into the olfactory lobes. These olfactory fibers divide into two groups, one of which passes cephalad to the olfactory lobe in the ventral wall of the cerebrum, while the other bundle passes gradually laterad, dorsad and then mesad to the extreme cephalic portion of the mesal wall. These are probably those mentioned and figured by Osborn in the dorsal aspect of the brain of *Siren*.

In the cinerea of the lateral wall just caudad of the olfactory glomeruli numbers of myelinic fibers appear which pass dorso-cephalad to the mesal wall. Whether or not these constitute a tract connecting the lateral and mesal walls of the olfactory lobe, or come cephalad from the peduncles in the cinerea, could not be determined.[1]

Upon the ventral surface of the cerebrum several small fascicles of amyelinic fibers go caudad from the olfactory lobes to the region immediately cephalad of the mesencephalic groove (mammillary region?) where they turn mesad and disappear. They undoubtedly represent a diencephalic olfactory tract and are shown in the figures as *olf. tr.* Some of these fibers decussate below the precommissure, others do not. They are shown in Figures 27 and 36 and in the transections through the regions they traverse.

---

[1]Since the above was written has appeared a paper by G. Elliot Smith in the *Anatomischer Anzeiger* (Vol. X, No. 15, pp. 470-474) on "The Connection between the Olfactory Bulb and the Hippocampus," in which is discussed a direct connection in the mesal wall, of the *fascia dentata* with the olfactory lobes, which was found in the Marsupial Brain (*Platypus*), and believed by him to be represented in the brain of the higher mammals by the striae Lancisii. Should that portion of the mesal wall in the amphibian brain to which the fibers of the dorsal commissure are distributed be shown to constitute a representative of the hippocampal region of the mammalian brain, it is suggested that the above described fibers might in that case represent a direct connection between the region of the olfactory glomerules and the mesal wall. In that event, however, the olfactory lobes would be almost entirely lateral, being represented in the mesal wall only by the extreme cephalic portion.

SUMMARY.

1. As compared with certain smaller urodeles, the brain of Necturus is greatly elongated. This appears to be due largely to a greater inequality between the rates of growth of the brain and skull. This is shown, it is thought, especially by (*a*) the almost entire absence of a pons flexure, (*b*) the length of the olfactory nerves, (*c*) the extent of the diatela.

2. A callosum is considered to be entirely absent in the amphibian brain: what has been generally regarded as such is here thought to be a hippocampal commissure, in part at least, although the homology should be dependent on comparative study.

3. An olfactory tract upon the extreme ventral surface of the cerebrum may be traced to the region just caudad of the the infundibulum,—presumably the region of the albicantia.

4. The paraphysis is well developed and in communication in the adult with the encephalic cavities. The postparaphysis of some authors is not regarded as a true evagination.

5. The fiber relations in the oblongata have been investigated to a certain extent; especial attention having been paid to the posterior longitudinal fasciculus, the dorsal tracts, lemniscus and the arcuate fibers.

6. The ental origins of the cranial nerves are worked out more or less completely. For general results Tables on pages 179 and 191 may be consulted. In particular, the motor portion of the facial nerve is shown to have the same mode of origin as in the majority, at least, of vertebrates. The first two roots of the vago-glossopharyngeal group, stated to be the representative of the lateral nerve of "fishes," and the nerve termed "dorsal seventh," are composed of fibers of the same appearance and terminate in the dorsal region of the oblongata in the neighborhood of the eighth nerve.

7. Mauthner fibers were demonstrated in the adult *Necturus*, *Amblystoma* and *Diemyctylus*. *Amblystoma* is a land form, hence there is no direct correlation with an aquatic mode of life

8. *A ligamentum denticulatum* is present in *Necturus*.

9. The mesencephalic pit is well marked in *Necturus*.

10. The fourth nerve is distributed in part to the metaplexus (or the dura). It is possible that such fibers are sensory, although no distinct ganglion was seen.

11. Myelinic nerve fibers from the mesencephal pass to the ectal surface of the brain immediately ventrad of the epiphysis; these may possibly represent a parietal nerve.

12. The optic nerve in Necturus is hollow for a portion of its length and the fibers of which it is formed are amyelinic; being in both these respects in a primitive condition.

ITHACA, N. Y., June, 1895.

LIST OF PAPERS REFERRED TO.*

'83. AHLBORN, FRIEDRICH. Untersuchungen über das Gehirn der *Petromyzonten. Zeitsch. f. wiss Zool.* Vol. XXXIX, pp. 191-294.

'82. BELLONCI. Intorno alla struttura e alla connessioni dei lobi olfattorii negli artropodi superiori e nei vertebrati. *R. Accademia dei Lincei. Memorie* XIII.

'83. BELLONCI. Sur la structure et les rapports des lobes olfactives dans les arthropodi superieures et les vertébrés. *Archiv Italiennes de Biologie.* 1883.

'87. BELLONCI. Sulle Commissure cerebrali anteriori degli Anfibia e dei Rettili. *Mem. del Real Accad. del Sci. dell. Istituto di Bologna.* Ser. IV, Tom VIII.

'90. BOETTIGER, A. Beitrag zur Lehre von den chronischen progressiven Augenmuskellähmungen und zur feineren Hirn-anatomie. *Arch. f. Psychiatrie.* Vol. XXI. p. 554.

'93. BRANDIS, F. Untersuchungen über das Gehirn der Vögel. II Theil: Ursprung der Nerven der Medulla oblongata. *Arch. f. mikr. Anat.* Vol. XLI, pp. 623-649.

'94. BRANDIS, F. Untersuchungen über das Gehirn der Vögel. II Theil: Ursprung der Nerven der Oblongata. *Arch. f. mikr. Anat.* Vol. XLIII, pp. 96-116.

'91. BURCKHARDT, R. Untersuchungen am Hirn und Geruchsorgan von *Triton* und *Ichthyophis. Zeit. f. wiss. Zool.* LII., pp. 369-403.

'92. BURCKHARDT, R. Das Centralnervensystem von *Protopterus annectens.* Octavo, pp. 64, 5 Pl. Berlin.

* No bibliography of the brain in Amphibia is attempted. An apparently quite complete bibliography of the literature upon the central nervous system of the *Ichthyopsida*, comprising 395 titles, is given in a paper by A. Sanders, entitled "Researches in the Nervous System of *Myxine glutinosa*," London & Edinburgh, Williams & Norgate. 1893.

'91. DAVID, J. On the Histological Structure of the Medulla of *Petromyzon. Jour. Comp. Neur.* Vol. II, p. 92.

'88. DOHRN, ANTON. Studien zur Urgeschichte des Wirbelthierkörpers. XIII. Ueber Nerven und Gefässe bei *Ammocoetes* und *Petromyzon Planeri. Mittheil. aus der zool. Stat. zu Neapel.* Vol. VIII, pp. 233-306.

'86. EDINGER, L. Ueber Ursprungsverhältnisse des Acusticus und die directe sensorische Kleinhirnbahn. XI Versamml. südwestdeutsch. Neurologen und Irrenärtze zu Baden-Baden. May, 1886. See *Neurolog. Centralblatt.* 1886, p. 286.

'88. EDINGER, L. Untersuchungen über die vergleichende Anatomie des Gehirns. I Das Vorderhirn. Frankfurt a. M. 1888. 4 Pl.

'92. EDINGER, L. Untersuchungen über die Vergleichende Anatomie des Gehirns. II Das Zwischenhirn. Erster Theil: Das Zwischenhirn der Selachier und der Amphibien. Frankfurt a. M. 1892.

'93. EDINGER, L. Vorlesungen über den Bau der Nervösen Centralorgane des Menschen und der Thiere. 4th Ed. 1893.

'88. EWART, J. C. On the Cranial Nerves of Elasmobranch Fishes. Prelim. communication. *Proc. Roy. Soc.* Vol. 45, pp. 524-537.

'91. EWART, J. C. On the Lateral Line Sense-organs of Elasmobranchs. I, Sensory Canals of *Laemargus. Trans. Roy. Soc. of Edinburgh.* Vol. XXXVII. p. 51.

'92. EYCLESHYMER, A. C. Paraphysis and Epiphysis in *Amblystoma. Anat. Anz.* Vol. VII. pp. 215-217.

'95. EYCLESHYMER, A. C. The Early Development of Amblystoma, with Observations on some other Vertebrates. *Jour. Morph.* Vol. X. pp. 343-418.

'64. FISCHER, J. C. Anatomische Abhandlungen über Perennibranchiaten und Derotremen. Erstes Heft. Die Visceralbogen und Muskeln. Die Gehirnnerven. Quarto. pp. 172. 1864.

'93. FISH, P. A. A New Clearer for Collodionized Objects. *Proc. Amer. Micr. Soc.* Vol. XV, pp. 63-66.

'95. FISH, P. A. The Central Nervous System of *Desmognathus fusca. Jour. Morph.* Vol. X, pp. 231-286.

'86. FULLIQUET. Recherches sur le Cerveau du *Protopterus annectens. Recueil Zool. Suisse.* Vol. III, pp. 1-130.

'92. GAGE, S. H. An aqueous Solution of Hematoxylin which does not readily deteriorate. *Proc. Amer. Soc. of Micr.* Vol. XIV, pp. 121-7.

'93. GAGE, SUSANNA P. The brain of *Diemyctylus viridescens* from larval to adult life, and comparisons with the brain of *Amia* and *Petromyzon. The Wilder Quarter-Century Book,* 259-313. Ithaca, N. Y.

'70. GEGENBAUR, CARL. Ueber die Kopfnerven von *Hexanchus* und ihre Verhältniss zur Wirbeltheorie des Schädels. *Jen. Zeitschr.* VI, 1870-1.

'94. GEHUCHTEN, A. VAN. Contribution à l'etude du Systéme nerveux des Teleostéens. Communication preliminaire. *La Cellule.* Vol. X, pp. 255-295.

'75. GOETTE, A. Entwicklungsgeschichte der Unke. Leipzig.

'88. GORONOWITSCH, N. Das Gehirn und die Cranial-nerven von *Acipenser ruthenus. Morph. Jahrb.* Vol. XIII, pp. 427-574.

'93, 1 HERRICK, C. L. Contributions to the Comparative Morphology of the Central Nervous System. II. Topography and Histology of the Brain of certain Reptiles. *Jour. Comp. Neur.* Vol. III, pp. 77-106.

'93, 2 HERRICK, C. L. Same. *Jour. Comp. Neur.* Vol. III, pp. 119-140.

'93, 3 HERRICK, C. L. The Callosum and Hippocampal Region in Marsupial and Lower Brains. *Jour. Comp. Neur.* Vol. III, pp. 176-182.

'94. HERRICK, C. JUDSON. Studies from the Neurological Laboratory of Denison University. XI. The Cranial Nerves of *Amblystoma*. *Jour. Comp. Neur.* Vol. IV, pp. 193-207.

'92. HIS, WILHELM. Zur allgemeine Morphologie des Gehirns. *Arch. f. Anat. u. Physiol. Anat. Abth.* 1892. pp. 346-383.

'94. HUMPHREY, O. D. On the Brain of the Snapping Turtle (*Chelydra serpentina.*) *Jour. Comp. Neur.* Vol. IV, pp. 73-116.

'76. JACKSON, W. H. AND CLARK, W. B. The Brain and Cranial Nerves of *Echinorhinus spinosus* with notes on the other Viscera. *Jour. Anat. and Physiol.* Vol. X, pp. 75-107.

'87. JULIN, CHARLES. Recherches sur l'appareil vasculaire et le systéme nerveux peripherique de *l'Ammocoetes* (*Petromyzon Planeri*). *Arch. de Biol.* Vol. VII, pp. 759-902.

'92. KINGSLEY, J. S. The Head of an embryo *Amphiuma*. *Amer. Nat.* Vol. XXVI, pp. 671-680.

'84. KLAUSSNER, F. Das Rückenmark des *Proteus anguineus*. Abstract in *Biol. Centralblatt.* Vol. III, pp. 271-272.

'93. KOELLIKER, A. Handbuch der Gewebelehre des Menschen. Zweite Band. Erste Hälfte. Leipzig, 1893.

'88. KOEPPEN, MAX. Zur Anatomie des Froschgehirns. *Arch. f. Anat. u. Physiol. Anat. Abth.* pp. 1-34. 1888.

'92. KOEPPEN, M. Beiträge zur vergleichenden Anatomie des Centralnervensystems der Wirbelthiere. Zur Anatomie des Eidechsengehirns. *Schwalbe's Morphologische Arbeiten.* 1ste. Band. pp. 496-515.

'93. LEE, A. B. The Microtomist's Vade-Mecum. 3rd Ed. London, 1893.

'81. MAYSER, PAUL. Vergleichend-anatomische Studien über das Gehirn der Knochenfische mit besonderer Berücksichtigung der Cyprinoiden. *Zeitsch. f. wiss. Zool.* Vol. XXXVI, pp. 259-364.

'92. MEYER, AD. Ueber das Vorderhirn einiger Reptilien. *Zeitsch. f. wiss. Zool.* Vol. LV, 63-133.

'90. NAKAGAWA, ISAAC. The Origin of the Cerebral Cortex and the Homologies of the Optic Lobe Layers in the lower Vertebrates. *Jour. Morph.* Vol. IV, pp. 1-10.

'90, OBERSTEINER, HEINRICH. The Anatomy of the Central Nervous Organs in Health and Disease. Trans. by Alex. Hill. Phil'a. 1890.

'83. OSBORN, HENRY F. Preliminary Observations upon the Brain of *Amphiuma*. *Proc. Phil'a. Acad. Nat. Sci.* 35-36. July 1893, pp. 177-186.

'84. OSBORN, H. F. Prelimary Observations upon the Brain of *Menopoma* and *Rana*. *Proc. Phil'a. Acad. Nat. Sci.* Vol. XXXVI, p. 262-274.

'86. OSBORN, H. F. The Origin of the Corpus Callosum; a Contribution upon the Cerebral Commissures of the Vertebrata. *Morph. Jahrb.* Vol. XII., pp. 223-251, and 530-543.

88. OSBORN, H. F. A Contribution to the Internal Structure of the Amphibian Brain. *Jour. Morph.* Vol. II., pp. 51-96.

'95. PINKUS, F. Die Hirnnerven der Protopterus annectens. Schwalbe's *Morph. Arbeiten.* Vol. IV, 1895.

'91. VON PLESSEN, BARON JOV., and RABINOVICZ, J. Die Kopfnerven von *Salamandra maculosa* im vorgerückten Embryostadium. J. F. Lehmann, Munich 1891. 20 pp.

'83. RABL-RUECKHARD. Das Grosshirn der Knochenfische und seine Anhangsgebilde *Arch. f. Anat. u. Physiol. Anat. Abth.* pp. 278-322. 1883.

'64. REISSNER, E. Bau des centralen Nervensystems der ungeschwanzten Batrachier. mit Atlas 12 Taf. Dorpat. 4to. 1864.

'92. REX, HUGO. Beiträge zur Morphologie der Hirnvenen der Amphibien. *Morph. Jahrb.* Vol. XIX., pp. 295-311.

'93. SALA, LUIGI. Ueber den Ursprung des Nervus acusticus. *Arch. f. mikr. Anat.* Vol. XLII., pp. 18-52.

'86. SANDERS, A. Contributions to the Anatomy of the Central Nervous System in Vertebrate Animals. *Plagiostomata. Phil. Trans.*, Vol. CLXXVII. Pt. II. 1886, pp. 733-766.

'89. SANDERS, A. Contributions to the Anatomy of the Central Nervous System of *Ceratodus Forsteri. Annals and Mag. of Nat. Hist.* Vol. VI, 3. pp. 151-188.

'93. SCHAEFER, E. A. Quain's Anatomy, Vol. III, Pt. I. The Spinal Cord and Brain. 10th. Ed. London 1893.

'82. SCHOEBL, JOS. Ueber die Blutgefässe des cerebrospinalen Nervensystems der Urodelen. *Arch. f. mikr. Anat.* Vol. XX, pp. 87-92.

'94, 1 SORENSEN, A. D. Comparative study of the Epiphysis and Roof of the Diencephal. *Jour. Comp. Neur.* Vol. IV., pp. 12-72.

'94, 2 SORENSEN, A. D. Same. *Jour. Comp. Neur.* Vol. IV., pp. 153-170.

'68. STIEDA, L. Studien über das centrale Nervensystem der Knochenfische. *Zeitsch. f. wiss. Zool.* Vol. XVIII., pp. 1-68.

'70. STIEDA, L. Studien über das centrale Nervensystem der Wirbelthiere. *Zeitsch. f. wiss. Zool.* Vol. XX., pp. 273-318. (Frog.)

'75. STIEDA, L. Ueber den Bau des centralen Nervensystems des *Axolotl. Zeitsch. f. wiss. Zool.* Vol. XXV., pp. 285-310.

'90. STRONG, O. S. The Structure and Homologies of the Cranial nerves of Amphibia as determined by their peripheral distribution and internal origin. *Zool. Anz.* Vol. XIII., pp. 598-607.

'92. STRONG, O. S. Same, Part II. *Anat. Anz.* Vol. VII., pp. 467-471.

'95. STRONG, O. S. The Cranial Nerves of Amphibia. *Jour. Morph.* Vol. X., pp. 103-230.

'95. STROUD, B. B. The Mammalian Cerebellum, Part I. The Development of the Cerebellum in Man and Cat. *Jour. Comp. Neurol.*, Vol. V., July, 1895, pp. 71-118.

'94. TURNER, W. A. The central connections and relations of the Trigeminus Vago-glossopharyngeal, Vago-Accessory and Hypoglossal Nerves. *Jour. Anat. and Physiol.* Vol. XXIX

'76. WILDER, B. G. On the the Brains of some fish-like Vertebrates. *Amer. Assoc. Adv. Sci., Proc.* Vol. XXV., pp. 257-259.

'80. WILDER, B. G. The Crista fornicis, a part of the mammalian Brain apparently unobserved hitherto. *Amer. Assoc. Adv. Sci.* 1880 ; *N. Y. Med. Record*, Vol. XVIII., p. 328. 1881.

'84, 1 WILDER, B. G. The Cartwright Lectures on Methods of Studying the Brain. Lecture I. *New York Medical Journal.* Feb. 9, pp. 141-148.

'84, 2 WILDER, B. G. Do the Cerebellum and Oblongata represent two encephalic Segments or only one? *Proc. Amer. Ass'n. for the Adv. Sci.* Vol. XXXIII, pp. 523-5. 1884.

'89. WILDER, B. G. Article, "Brain, Gross or macroscopic Anatomy." *Reference Handbook of the Medical Sciences.* Vol. VIII, pp. 107-164. 104 Figs.

'93. WILDER, B. G. Article, "Brain, Gross or macroscopic Anatomy." Supplementary article. *Reference Handbook of the Medical Sciences.* IX, *Supplement.* pp. 99-111. 10 Figs.

'84. WRIGHT, R. Ramsey. On the Nervous System and Sense organs of *Amiurus. Proc. Canadian Institute, N. S.* Vol. II., pp. 352-386.

'52. WYMAN, JEFFRIES. Anatomy of the Nervous System of *Rana pipiens. Smithsonian Contributions to Knowledge.* Vol. V., Article 4.

DESCRIPTION OF FIGURES.

All the figures with exception of 1, 2, 4, and 41 were outlined by the aid of the Abbe *camera lucida.* Figs. 1 and 2 were drawn from enlarged photographs, while 4 and 41 were reconstructed from series of sagittal sections. In the description of each figure the approximate degree of magnification is given. In all frontal sections and transections the right side of the figure corresponds with the right of the observer. Myelinic fiber tracts are given in blue, amyelinic in black. An especial effort has been made to indicate clearly the continuity of the endyma and the concomitant circumscription of the cavities in accordance with the precept and example of Prof. Wilder; see, in particular, his note on the "Morphological Importance of the Membranous or other thin Portions of the encephalic Cavities," *Jour. of Comp. Neurology*, Vol. I., pp. 201-203, 1891.

ABBREVIATIONS.

a.—aula (mesal part of prosocœle.)
asc. V.—ascending tract of the fifth nerve.
asc. X.—ascending fibers of the tenth nerve.
a. v. c.—anterior vertical canal.
b. p. t.—basal prosencephalic tract.
cb.—cerebrum.
ch.—chiasma.
cbl.—cerebellum.
comm. tr.—commissura transversa.
cto.—commissura tecti optici.
mf.—Mauthner fiber.
m. g.—mesencephalic pit.
mlc.—myelocœle.
mt.—metatela.
mtc.—metacœle.
mtplx.—metaplexus.
m. V.—mesencephalic tract of the fifth nerve.
obl.—oblongata.
of.—optic fibers.
olf.—olfactory.
olf. tr.—olfactory tract (text).

dc.—diacœle.
d. comm.—" dorsal " commissure of the text.
d. e.—ductus endolymphaticus.
Dien.—diencephal.
dplx.—diaplexus.
dt.—diatela.
e. h. c.—external horizontal canal.
Epen.—epencephal.
epiph.—epiphysis.
f. c.—fasciculus communis.
gl.—glomerule.
gln.—ganglion.
hb.—habena.
hyph.—hypophysis.
infd.—infundibulum.
l.—lemniscus.
l. r.—lateral recess.
mb.—Meynert's bundle.
m. c.—Mauthner cell.
mc.—mesocœle.
Mesen.—mesencephal.
Meten.—metencephal.
on.—optic nerve.
or.—optic recess.
p.—porta (foramen of Monro).
paraph.—paraphysis.
pc.—paracœle ('lateral ventricle').
psc.—postcommissure.
plf.—posterior longitudinal fasciculus.
por.—preoptic recess.
pplx.—prosoplexus.
prc.—prosocœle (entire cavity of prosencephal.
prcs.—precommissure.
Prosen.—prosencephal.
rc.—rhinocœle.
Rhinen.—rhinencephal.
s. e.—saccus endolymphaticus.
sp.—spinal.
spcs.—supracommissure.
splx.—supraplexus.
t.—terma.
tr. a.—tract *a.* (text)
tr. b.—tract *b.* (text)
vel.—velum (transversum).

PLATE IX.

Fig. 1. The brain of *Necturus maculatus*, dorsal aspect. x 5.4.

Fig. 2. The same from the ventral aspect. x 5.4.

Fig. 3. The same, lateral aspect. x 5.4. The cranial nerves are shown but diagrammatically, as is to a less extent their representation in Fig. 1 and 2.

Fig. 4. The mesal aspect of the brain as reconstructed from sagittal sections. x 9.

Fig. 5. Latero-ventral aspect of the oblongata to show the roots of the cranial nerves. This is a reconstruction from transections and is diagrammatic; the roots of the seventh and eighth nerves are, for the sake of clearness, separated somewhat more widely than is actually the case. (See Fig. 19.)

Fig. 6. The metaplexus from the ental aspect to show the arrangement of the folds.

Fig. 7. Transection through the brain of a larval Necturus, 6-8 weeks old, at the level of the "dorsal" commissure. The precommissure appears a few sections farther cephalad. x 31.5.

Fig. 8. Transection of the brain of a just hatched larva, at the portas, to show the paraphysis. x 31.5.

PLATE X.

Fig. 9. Transection of the myel in the cervical region near the 3rd (1st ganglionated) spinal nerve. x 22.

Figs. 10-20. A series of transections through the myel and oblongata, to illustrate its structure and the origin of the cranial nerves ; from a series fixed in Hermann's fluid. The nerve cells are represented necessarily diagrammatically and somewhat enlarged. The metatela is shown merely in outline.

Fig. 10. Transection of the myel near the second spinal nerve.

Fig. 11. Transection at the beginning of the metatela. x 22.

Fig. 12. At the level of the exit of the last root of the Vagus nerve, (X^7). x 22.

Fig. 13. At the exit of the first root of the Vagus (X^1). x 22.

Fig. 14. At the level of the glossopharyngeus (IX^{3+4}). x 22.

Fig. 15. At the entrance of the "dorsal ninth" (IX^{1+2}). x 22.

Fig. 16. Transection between IX^1 and VIII. x 22.

Fig. 17. At the level of the seventh and eighth nerves. x 22.

Fig. 18. A portion of a transection in the region of the eighth nerve showing the form and relations of the Mauthner cell. x 42.5

Fig. 19. A transection between the seventh and fifth nerves, at the division of the "dorsal seventh" (VIIb) one branch going to the Gasserian ganglion (½ VIIb, Fig. 1). x 22.

Fig. 20. At the exit of the fifth nerve. x 22.

Fig. 21. Transection farther cephalad, at the rising of the lemniscus, and showing the lateral extensions of the metencephal, the hypophysis and *saccus vasculosus*. x 14+.

Fig. 22. Transection at the mesencephalic groove and the entrance of the third nerve. Attention is called to the large cells of the mesencephalic trigeminal nidus and the fibers from the olfactory region which end in this neighborhood. (Tr. olf.) x 14+.

Fig. 23. Transection at the transverse commissure showing the epiphysis and the beginnings of the peduncular tracts ; also fibers joining them from the thalamus (walls of the diacœle). x 18+.

Fig. 24. A transection through the cranium and ear capsules to show the relation of the endolymphatic sac to the brain. The walls of the membranous ear are distorted, the perilymphatic space being very large. Compare Figs. 17 and 19. x 8.3.

Fig. 25. A portion of a dorsal frontal section to show the paraphysis and the extension of the diacœle simulating a more caudal evagination, lined with cells differing in appearance from those of the paraphysis. x 14.

Fig. 26. A section slightly farther ventrad than the section shown in Fig. 25. x 9.

Fig. 27. A frontal section far ventrad, following Fig. 35, Plate XI. It passes through the precommissure and the mesencephalic groove. Just caudad of the mesencephalic groove, fibers are shown decussating ; cephalad of it are fibers from the olfactory lobes. x 6.6.

PLATE XI.

Fig. 28. Transection at the level of the optic nerves. The tract of the supracommissure is also shown passing to the lateral walls of the cerebrum. x 18+.

Fig. 29. Transection slightly caudad of the portas. Fibers are shown collecting from the caudal mesal walls of the hemicerebrum and from the diencephal to take part in the dorsal commissure, the caudal edge of which is also shown. The diatela is greatly expanded. x 18+.

Fig. 30. Transection through the precommissure and the portas, through which extend the paraplexuses, intruding from the supraplexus, which encloses the paraphysis. The fibers of the dorsal commissure appear as a bundle roofing the portas. Compare with the more caudal section, Fig. 42. x 18+.

Fig. 31. A transection just cephalad of the terma where the paracœles are limited in the mesal walls by endymal cells alone. x 18+.

Fig. 32. Farther cephalad than section 31. The cinerea reaches the ectal surface in the mesal walls. x 14+.

Fig. 33. A transection through the olfactory lobes showing the glomerules and the ectal cinerea upon the ventral and dorsal aspects in this region. x 18+.

Fig. 34. A frontal section through the prosencephal. x 6.6.

Fig. 35. A frontal section at a more ventral level. It may be compared with the preceeding and with Figs. 44 and 42 for the relations of the dorsal commissure. x 6.6.

Fig. 36. A frontal section near the ventral surface of the brain. It shows a decussation of a portion of the olfactory fibers ventrad of the precommissure. x 6.6.

Fig. 37. A frontal section through the chiasma. x 12.5.

Figs. 38, 39 and *40.* Sagittal sections through the brain, 38 the most nearly mesal. In Figs. 38 and 39 appear fibers of the dorsal commissure, in all, the transverse commissure. Fig. 39 also shows Meynert's bundle and the postcommissure. x 11—.

Fig. 41. A mesal section through the brain of a larval Necturus, 4 weeks old. Reconstructed from sagittal sections through the head. x 9.

Fig. 42. A transection through the dorsal commissure. A portion of the precommissure only is shown, so that the relations are not well represented in transection, for which the mesal section should be consulted, Fig. 4. Fig. 42 is intermediate between Figs. 29 and 30. x 9.

THE CORTICAL OPTICAL CENTRES IN BIRDS.[1]

By Dr. Ludwig Edinger.

Synopsis of an Address at the Meeting of Southwest German Neurologists and Psychiatrists, 1895.

Dr. Edinger had demonstrated to the Association in former meetings how gradually the cortex has developed in the animal series from insignificant beginnings. The latest investigation concerns the question, "Which fibre systems were earliest to develop to or from this cortex?"

A year ago it was demonstrated to the Association that the earliest cortical connections, appearing in reptiles, belong to the olfactory apparatus (olfactory radiations and fornix). It is now possible to locate a tract from the cortex to the optical centres. This appears to be absent in reptiles but is so highly developed in birds (pigeons) that it may be considered as the strongest tract of the cerebrum. The tractus occipito-tectalis, as it is termed by Edinger, arises near the brain base quite in the occipital region and passes cephalad, curving ventrad cephalad of the precommissure. It may be followed into the mesencephalon where the optic nerve terminates. The region of origin of this bundle in birds is where the axial lobe is but imperfectly separable from the cortex and is accordingly not to be distinguished from the former with certainty, but from its peripheral origin it is regarded as a cortical tract rather than the most caudal portion of the radiations from the axial ganglion. The tract becomes medullated some weeks after hatching exactly as in the mammals where it has the same termini.

The course was verified by serial sections and especially by the results of degeneration. Three pigeons from which the occipital region was removed by operation were preserved alive for three weeks. In these the tract was completely degenerate.

---

[1]Authorized translation from Arch. f. Psychiatrie, XXVII, 3.

In the thalamus it occupies the most dorso-lateral region of the basal cerebral bundle and ends behind the chiasm after passing laterad in the deepest layers of the mesencephalon in broad divarications. At least Marchi preparations do not enable us to trace it further. Bumm has recognized the origin in the cortex but not the terminus in the mesencephalon. It is Bumm's "dorsale hirnschenkel abtheilung." Birds also possess another tract to the mesencephalon, the "Bündle der sagittalen Scheidewand" [so-named by Bumm but called by C. H. Turner "tractus Bummi"] the course of which was also traced in degeneration preparations. It does not end in the optic centres but in a special nidulus lying cephalad of these and whose relation to the optic system is yet to be proven.[2]

Dr. Edinger then demonstrated this long associational tract which appears first in birds.

Since the present state of our knowledge warrants the view that the cortex is the seat of those psychical functions which are carried on consciously by means of reflection with employment of memory images, such a discovery of cortical tracts connecting with niduli of special sensory apparatus has a high degree of interest from the standpoint of comparative psychology. It now becomes more easily intelligible that birds exhibit in some of their activities very highly developed optical memory capacity. The lower terrestrial vertebrates may find all their vital necessities accommodated for by the impression afforded by the sense of smell, but in the case of birds this would not be advantageous. On the contrary, as they float far above their food or roosts they must be able to recognize them by means of vision and especially to distinguish them from moving objects spuriously resembling their prey. Illustrations were cited by the speaker and by the ornithologist, Dr. Wurn.

[See editorial note elsewhere in this number.]

---

[2]It may be recalled that Turner traced this tract from "frontal or the fronto-median lobe" beneath the precommissure to the outer layer of the tectum. His methods were such as permitted ambiguity.

EDITORIAL.

The Cortical Optical Centre in Birds.

The address which appears in synopsis elsewhere in this number prompts us to call attention to the fact that the tract described by Dr. Edinger is by no means the earliest connection found between cerebrum and the optic centers. It does not appear from the paper what part of the tectum is the terminus of the "tractus occipito-tectalis" but it is obvious that it is a *direct* associational tract. Even in fishes the writer has distinguished a strong tract entering the axial (cerebral) lobe from diencephalic niduli and effecting connections with other regions. Among these is a contingent springing from the geniculata of either side where they arise in large "switch cells" one limb of which seems to be connected with tectal tracts. Now, the writer claimed several years ago that the axial lobe of fishes must contain in potential the elements of the cortex and that the elementary connections would all be discovered there. Histological evidence was brought forward to show that the axial lobe is by no means the simple homogeneous structure it had been supposed. *It cannot be homologous to the striatum. First,* it contains a multitude of distinct niduli. *Second,* these niduli differ among themselves in form, size, color reactions and processes. *Third,* the tracts connecting these niduli pass in various directions. For example, in the cephalic parts large cells give rise to axis-cylinders passing into the ventral peduncles. In the meso-caudal portion is a cell cluster on either side which receives the lateral olfactory radix in exactly the same way that the pyriform lobe of mammals does and since a homologue of the descending fornix springs from the same cell mass and passes to the mammillaries (which positively occur in all fishes in the usual place and have nothing to do with the hypoaria) it seems necessary to consider that the cell cluster contains the homologon of the hippocampus.

The existence of a cephalic commissure aside from the precommissure and olfactory decussation (whether one should think of a callosum or not in that connection) is also in point. In other fishes than the teleosts we find still greater evidence that such a consolidation has taken place ; in fact nearly all steps between the ichthic and amphibian brain are now known. This does not necessarily open the question as to the pallium which in spite of the acrimonious discussion it has awakened is really a very narrow morphological problem. Whether the pallium represents the cortex of other groups or whether it is the median plexiform prolongation which in higher forms serves a nutritive function and lies within the ventricle is a question incapable of arbitrary solution. The two are continuous and at an early stage are indistinguishable. The distinction can only be a functional one and from a broad morphological point of view is not worth discussing. The great fact remains that the ventricle is enclosed in all forms alike by the product of the embryonic vesicle. To return to our original question. It is seen that in all craniates there is a sensori-motor loop in the cerebrum and that in all forms of which we have sufficient data the tectum is indirectly connected with the pallium or its homologon. We venture to differ from Dr. Edinger in his sweeping statement that the olfactory function is the only special sense which enters the psychic life of infra-avian vertebrates but believe that we have evidence which may soon be elaborated to show that reptiles also have their optic associations. However, the interest attaching to Dr. Edinger's generalization is not diminished thereby. In birds, we are told, a large *direct* associational tract becomes conspicuous and is correlated with the predominant visual element in their régime.

C. L. HERRICK.

* * *

NEUROLOGY AND MONISM.

The question often obtrudes itself, "Does modern neurology afford any evidence toward a dualistic construction in psychology?" The answer may be both "yes" and "no" and the consideration of the two answers may indicate to some ex-

tent the limitations of neurology as a handmaid of psychology. The problem is, in reality, very simple so long as the bounds of neurology are not overstepped.

We naturally approach the subject from the æsthesodic side. In other words, we enquire, does the mass of stimuli which forms the incentive to all subjectivity reach consciousness in more than one form, and, if so, are these various forms capable of producing different "aspects" of reality? Of course an affirmative reply can be given to the question in its first form at once. All stimuli of the higher senses habitually present themselves to the cortical or conscious centres in a double way. In the case of vision, for example, the perfect visual stimulus reaches the tectum and undergoes the complicated analysis which the structure and genetic relations of the latter to the retina so strongly suggest and then effects coördinations with the occulomotor mechanism, completing the entire visual act, even to the connections with the automatic efferent centres. No cortical consciousness is involved in these processes but the latter is provided for by "associational tracts" connecting with the occipital cortex where other cortical connections are effected. Our point here is simply that the whole visual process is completely out of the conscious sphere and mechanism and that a separate loop is developed in higher animals to effect the cortical communication. Now when an objective image is formed on the retina and the physiological processes of vision, accomodation, etc. follow, a second and entirely distinct process may be induced, under suitable circumstances, in the cortex to which alone the perception of the object is due. A decorticated dog will see perfectly well and avoid obstacles, but is unable to perceive or recognize the object.

Under other circumstances it may happen that the cortical region may be excited by a stimulus other than those arising in the optic lobes and there will follow a more or less perfect revival of some of the various processes which had previously been inaugurated by a visual excitement. The second form of cortical excitement is due to a vestige and may be called a vestigeal or indirect. This is often spoken of loosely as a subjective

image as contrasted to an objective. But from a psychical point of view one is quite as objective as the other, while, if the distinction is a physiological one, it is obvious that there are at least two other varieties of "subjective images" possible, (1) those due to disturbances in the eye ball, (2) those due to irritation of the tectum. Perhaps, however, the last two cannot be physiologically distinguished and may grouped as tecto-retinal. It is, however, apparently true that the tone of the cortical image is different from that superposed on the infracortical processes described. (It is not necessary to do more than indicate that besides the direct associational tracts here alluded to there are indirect connections between the optic lobes adequate to explain the dissimilarity between the vestigeal and the objectively-occasioned visual process in the cortex.) Much ambiguity still prevails in the attempt to discriminate different types of visual reproduction. There is hardly a question that involuntary reproduction may be either vestigeal or hallucinatory (tecto-retinal). In the latter case the actual colors and forms are as really presented as if an object were before the eye. On the other hand, it is very doubtful if voluntary reproduction is ever other than vestigeal. The conscious differences in tone between the two forms of sense perception are not, as often claimed, matters of degree—they are differences of kind or tone. How this difference arises it is needless to enquire; it may be that, besides the visual impression directly formed, the profound disturbances and coördinations in the mesencephalon during vision produce a great variety of modifications of consciousness. It would be strange if it were otherwise.

Ordinarily cortical vision involves a vast system of interactions between different centres, giving rise to perception and higher mental acts. Perception, for example, must not be thought of as a definite category of coordinate processes. Rather, the act may be very simple or highly complex, depending on the number of vestiges coordinated in it. The higher processes are higher not because of this kind of complexity but because of a greater degree of kinesodic participation, i. e. because there is a coordination of higher and lower centres in-

stead of a great number of similar centres. (Of course, according to a dynamic theory, the act of consciousness is not the result of an excitation in any cell or cells but is produced by the impinging of an æsthesodic upon a kinesodic system in reciprocal reaction. The transmission of nervous force does not produce a higher force; but the peculiar interference or increase of tension of nerve forces in antagonistic equilibrium does. Consciousness depends on the dynamic element—a translation of force into energy and thus, *to us*, there seems to be a complete hiatus between consciousness and all other phenomena.)

The above illustrations may serve to show that in the presentative field there are two forms of neurosis which enter into our ideas of subjective and objective. But we seem to have ignored the most obvious distinction—the various degrees of æsthetic value which the presentations possess. Upon the theory of pleasure-pain elsewhere proposed it is possible for any sensation to present with its own proper content other stimuli due to the quantitative relations of the stimuli. (It may be noticed in passing that the apparent difficulty in this theory—its incompetence to explain the pains of negative states, as ennui etc., is only apparent. Whether a stimulus is painful or not depends not on the absolute intensity of the irritation but on the capacity of the mechanism to transmit it. In ennui the sluggish system is incapable of reacting against the slight stimuli and their monotonous character causes a summation and intermittent discharge. In fatigue the exaggerated bodily processes of repair are sufficient to create summations in the enfeebled nerve centres. In either case the awakening of attention will remove the symptoms.)

We conceive that the greater quantitative element involved where pleasure-pain increments are present to a high degree accounts for the tendency of such presentations to awaken kinesodic responses and that we reach by this means essentially the same difference as that between the vestigeal and the "objective" presentation. That is, in the presentation essentially devoid of algedonic color, as in the vestigeal one, there is wanting the reflected glow of the extra-focal processes which in the

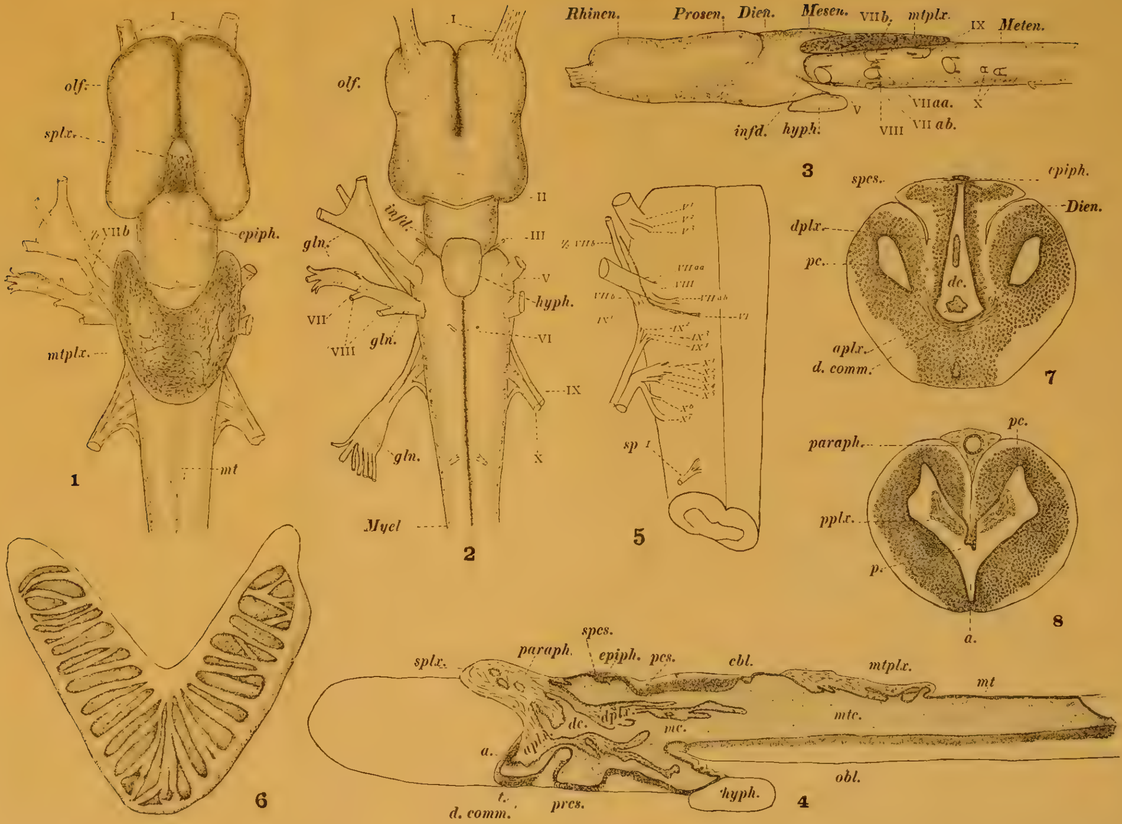
other cases constitutes a quale of the perception or the like. There is a dualism then dependent on the extent to which the direct impression is reinforced by indirect or reflected results of the stimulus.

On the kinesodic side a somewhat similar dualism exists. Thus the motor origins whence the real nervous force involved in our acts is derived are chiefly infra-cortical. The vast majority of such acts are performed without the aid of consciousness. Even in cases where the subsidiary cortical current actually passes it may awaken no consciousness. (This is explained upon a dynamic theory of consciousness. The cells are indeed excited by the current but, for whatever reason, no interference or kinesodic reaction is produced. Only when an antagonistic wave is set up is consciousness possible. This does not, however, prevent an unconscious process from awaking consciousness afterwards by vestigeal action.) But when both æsthesodic irritation and kinesodic response occur in consciousness we acquire a new idea of relation, i. e. sequence, cause. When the preliminary to the kinesodic discharge is a complicated coordination of vestiges the response acquires a highly purposive character. (It is worth noting in this connection that such ideas as sequence, duality, plurality, multiplicity, etc., must of necessity have a unitary or qualitative psychological basis. Crudely illustrating the nature of the neuroses in this field, we might suggest that the superposition of similar vestiges would give rise to an impression of identity while the superposition of an "objective presentation" upon a vestigeal one of the same kind produces the impression of succession. Time in its purely presentative aspect seems capable of a somewhat similar construction.) Those kinesodic activities which deal with the reactions of motor vestiges on sensory vestiges of successively higher orders bring us to the higher intellectual processes. We come, at any rate, to the apprehension of processes felt by us and processes not felt by us—things "done by us" and things "not done by us." We have here the two "points of view" on which Morgan *et al.* rely to establish two "aspects of reali-

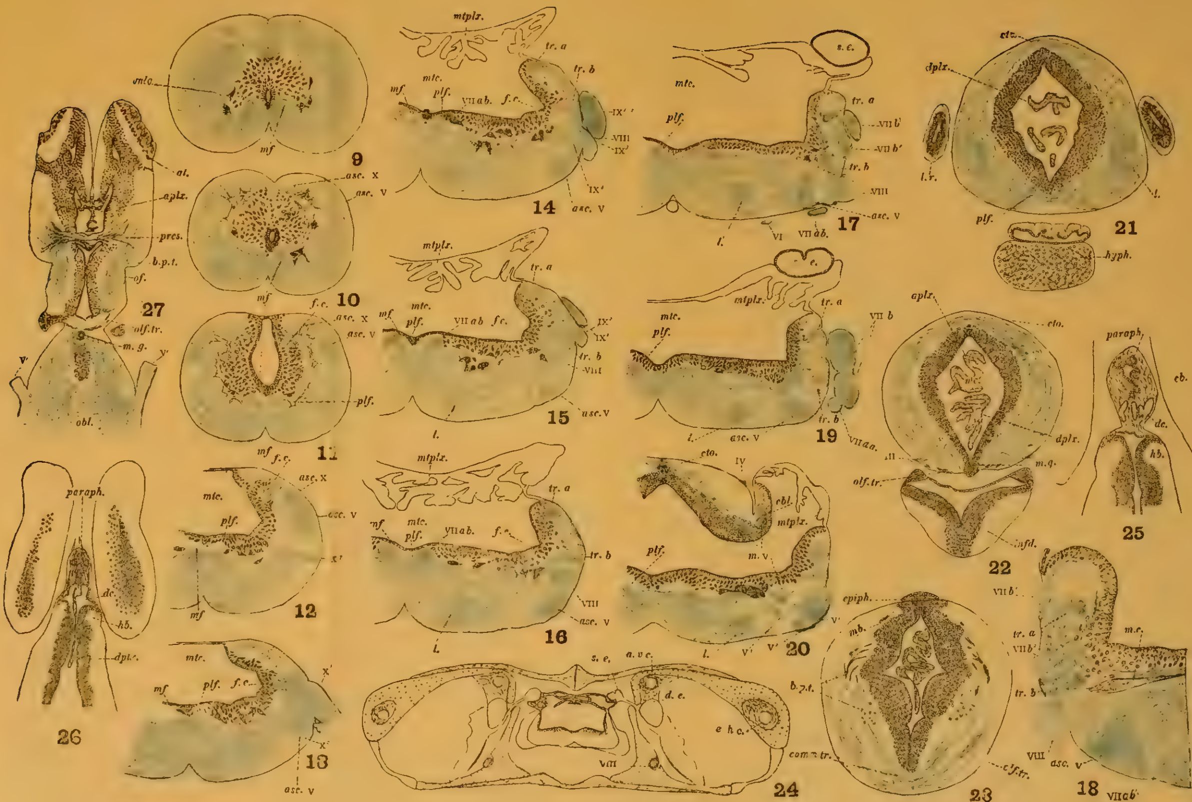
ity." Our analysis, tabetic as it has been, serves to indicate how insufficient the data are to serve as criteria of reality.

Only one thing of all this is psychical—consciousness. Our idea of non-conscious activities is reached by the method of difference. Our judgement that part of our acts are unconscious means simply that the same sensory state is often combined with different amounts of kinesodic activities. A "dualism of experience" does not exist, only a dualism of judgement. Consciousness does not give us directly a distinction between self and not self. Self is a conception dependent not on the antinomies of the conscious and non-conscious but on the variable mixtures of kinesodic and æsthesodic actions. Do we then at last find the two aspects of experience in the two phases of consciousness due to kinesodic and æsthesodic action respectively? Evidently not. Consciousness of what I have done and what I have experienced are both irresolvable activities, though their physiological occasions are combinations. Consciousness is different from the neuroses or forces which occasion it, not another aspect of them. We may illustrate from physics. When two forces are in antagonistic equilibrium the forces are destroyed, i. e. are replaced by energy. This energy is something different from its component forces. Our dualism is one of limitations. Spatial relations are developed from sequences and before they reach perception are translated into the interaction of residua. Thus we speak of immediately perceiving a colored space as extended, limited, etc. But the concept of space arose in the first place through sequences of sensori-motor coördinations. After these are once formed they are represented by residua which serve to present spatial ideas, as we say, directly. In like manner we become through habit unconscious of the scaffold by which most of our higher concepts are reached.

It is not necessary to amplify farther. The suggestions from neurology seem to us to be consistent with neither dualism nor materialistic monism but instead with a form of dynamic monism. C. L. HERRICK.



I
olf.
splx.
VII b
epiph.
mtplx.
mt
1
infd.
gln.
II
III
V
hyph.
VII
VIII
VI
IX
X
Myel
2
Rhinen.
Prosen.
Dien.
Mesen.
VII b.
mtplx.
Meten.
VII aa.
VII ab.
infd.
hyph.
3
5
spcs.
epiph.
Dien.
dplx.
pc.
dc.
aplx.
d. comm.
7
paraph.
pplx.
p.
a.
8
6
splx.
paraph.
epiph.
pcs.
cbl.
mt
mtc.
mc.
a.
obl.
t.
d. comm.
prcs.
4




aplx.
hb
hb.
aplx.
pc.
pcs.
b.p.t.
olf. tr.
on.
28
dc
rel.
ppls.
d. comm.
29
32
or.
ch.
infd.
37
paraph.
splx.
pc.
d. comm.
pplx.
b.p.t.
pres.
olf. tr.
p.
30
d. comm.
olf. tr.
31
gl.
pplx.
aplx.
34
dc.
mb.
pcs.
mtc.
35
pcs.
cto.
splx.
or.
pplx.
38
rc.
gl.
33
mb.
pcs.
cbl.
mtplx.
b.p.t.
or.
pplx.
39
cbl.
mtplx.
b.p.t.
40
olf. tr.
comm. tr.
36
paraph.
dc.
pplx.
aplx.
d. comm.
prcs.
por
42
pcs.
spcs.
epiph.
paraph.
cbl.
dplx.
mtc.
aplx.
d. comm.
prcs.
obl.
hyph.
41

RECENT LITERATURE.

Popular Zoological Literature.[1]

There is scarcely anything so irritating as the miserable and claptrap material put forth by modern publishers as popular zoology. One may read and be entertained by blood thirsty hunting tales where every law of scientific probability and possibility is ignored. So much may be granted to the field of romance. But the absurdities perpetrated in the name of science for the education of youth deserve only condemnation. There is, for example, a so-called "Life of Audubon" bearing the imprint of a well-known firm which does not pretend to present a connected view of the career of this great natalist, of whom the *authoress* (we must use the word) evidently knew worse than nothing; but which contains a series of disconnected diatribes on natural history subjects which collectively, it is safe to say, present no single adequate or intelligible fact in science but at most illustrate the dangers of inexpert compilation.

Now-a-days such books usually have some moral—let us say, "the remarkable resemblance of reason to instinct," or "the clear evidence of reason among brutes," or, to be quite safe, the place of the moral is taken by a query, "can such remarkable conduct be due solely to instinct?"

Through the ceaseless efforts of a score of able scientific writers the idea has been finally inculcated that a study of nature is a duty incumbent upon every child and consequently such trash commands a rather brisk sale at least during the holidays. The average wide-awake boy soon detects the futility of this literature and acquires a very condescending attitude toward natural science, particularly zoology. Much has been said about comparative psychology of late. Unfortunately Romanes is unintelligible to most of the would-be readers and C. Lloyd Morgan has no double in actual zoological work so our dillitantes are giving us animal psychology whose only merit is in being "beastly."

[1]PORTER, J. HAMPDEN. Wild Beasts. A study of the characters and habits of the Elephant, Lion, Leopard, Panther, Jaguar, Tiger, Puma, Wolf and Grizzly Bear. Chas. Scribner's Sons. 1894.

The work before us and which has suggested without being responsible for these remarks comes in the familiar guise. Fortunately it is in this case a disguise; for, without being learned, it is intelligible, and its author knows enough not to foist upon us a nondescript psychology or fairy story of animal intelligence based on human consciousness and imagination. He writes with a settled purpose not to attribute motives to animals on the insecure basis of human analogy and we think he succeeds pretty well unless perhaps in those cases where long personal contact (as with the puma) has promoted the growth of an unconscious anthropomorphic ideal.

The materials are necessarily at second hand for a large part, but the selection is wide enough and intelligent enough to enable one to "sift the lie" from much of it. The description of habits is full and mostly good. Biological details otherwise are less happy and the psychological analysis scanty and not very satisfactory. There is sufficient incident to redeem the book from dullness and the illustrations are chiefly from photographs. Half-tones are not art and we have none of the fire of Specht but some elements of truth which chill one like the photographs of a race horse. Such illustrations are a hybrid between science and art and serve their purpose until a better thing—scientific art—shall appear.

There is much which is eminently quotable in the volume and we reproduce some passages which will convince the zoological reader that he can well afford to examine the book at length. The comparative psychologist will find considerable material gathered for his use and will understand how to make any necessary allowances.

Respecting the elephant we read "It is no longer said that elephants who, to use Colonel Barras' words, 'are practically sterile in captivity,' are so because of their modesty, or that this is attributable to a nobleness of soul which prevents them from propagating a race of slaves. Men would now be ashamed to say they are monotheists and retire to solitudes to pray. But so little of comparative psychology is known, and the side lights which other sciences thow upon zoology are so much disregarded, that no hesitation is felt at comparing them with human beings, or measuring the faculties and feelings of a beast by standards set up in civilized society." While essentially a social animal with family units the author thinks the evidence for hermit or rogue elephants is too strong to be disregarded. Moreover the animal is subject to insanity, exhibiting in such cases "all the features which form the characteristic physiognomy of mania." Ele-

phants are often hysterical and always nervous though discipline effects great changes in their ordinary conduct.

The chapter on the puma is most replete with data on psychology.

"Professor Prantl (Reformgedanken zur Logik) excogitated a metaphysical system for beasts from the standpoint of an assumption that the chasm which separated them from humanity is impassible. He admits their resemblance in essential nature. He agrees that the dissimilaritis which they exhibit are results of a difference in evolutionary degree, and then his whole argument goes to show that this is not the case, and that brute mind and human intellect are radically distinct in structure and function. As this analysis of the intelligence in mankind and inferior beings was made without reference to facts, it is not surprising that they should be traversed by these in all directions, and that almost everything which the professor asserts to be impossible, is well known to naturalists in a matter of actual occurence. Gato [a tame puma] himself set at naught many of his conclusions. He may not have exhibited either love, gratitude, sense of duty, or that spirit of self-sacrifice which dogs frequently, and other animals sometimes, display, but he certainly possessed the 'time sense' that Prantl attributes exclusively to man. His account of periods and seasons was as accurate as possible; he measured intervals and knew when they came to an end. This animal "was prone to contemplations that, as his eye and changing attitudes indicated, were not vague, apathetic dreams; no one can know that he did not revive mental states and meditate on concentrically initiated ideas." "Books amazed Gato. Nothing could be made out with regard to them by means of scent or sight; they were dead apparently, and not fit to eat. What was in them that never came out? Why should they be watched so closely? This question he never found any satisfactory answer to, and one might see that it often perplexed him." "Gato absolutely refused to learn English, and would only respond to communications made in the mother tongue."

"Many animals are exceedingly vain, nearly or possibly quite as much so as savage man, and vainer they could not be. Now this trait is inseparable from a desire for praise. Gato was found of display and delighted in being noticed and admired."

In the felidæ injuries are soon forgotten and nobody ever knew a lion or tiger to act in this regard like an elephant. "Deep, concentrated persistent feeling is beyoud the Felidæ. This is why Dio Cassius' story of Androcles and his lion is untrue; quite

as much a romance of the affections as Balzac's 'Passion du Desert.'"

But we might go on indefinitely. Enough has been selected to indicate the spirit of book which is, as we have shown, a somewhat heterogeneous but interesting mixture of the conventional anecdote book with psychological analysis. C. L. H.

Helmholtz as a Physiological Psychologist.[1]

Since the death of Darwin the loss of no one in the scientific world has made such an impression as that of Helmholtz. From the early beginnings of his career all his researches were directed toward high ends, and were crowned with great success. Whenever he smote the rock of nature, there gushed forth the living waters of knowledge. The two works upon which his fame most largely depends are within the province of physiological psychology. His "Physiological Optics" began to appear in 1856 and notwithstanding the enormous activity of that period, during which the labors of Brücke, Fechner, Brewster, Wheatstone, Maxwell and many others were in progress, Helmholtz took scarcely any results from others without independent verification. Like Reymond and Ludwig, he was of the school of Johannes Müller, but most of his highest achievements were due to his proficiency in mathematics and an innate mechanical tact and perception.

His name is permanently associated with that of Young in the theory of color vision which especially at the present time, is proving stimulating. Helmholtz is an empiricist rather than a nativist.

The second great psychophysical work, Lehre von Tonempfindungen, appeared in 1863 and, while many of its views begin to feel the effects of subsequent research, it will ever remain a monument of scientific progress. The personal bearing and individual life are described as modest and genial.

A Location Reaction Apparatus.

Professor G. W. Fitz of the Lawrence Scientific School attempted to test the power of an individual to quickly and accurately touch an object suddenly disclosed to him in an unexpected position. The apparatus designed for this purpose is described in the Psychological Review, II, 1, and consists in an arc within which the subject is concentrically placed. A drop screen is arranged to register the moment

---

[1]STUMPF, C. Hermann v. Helmholtz and the New Psychology. *The Psychological Review*, II, 1.

of exposure of the small white target. The pendulum myograph used for this purpose also registers the amount of error. No evident relation exists between the time employed and the accuracy displayed, but the time interval of females is longer while their motions are more accurate. It would appear that some such a system of tests might be employed in the study of the effects of various crafts.

The Motor Power of Ideas.[1]

The curious observation has been made that if one gazes fixedly at a light for twenty seconds or so, and then suddenly turns the head through an angle of 45 degrees, he has an after image in the direction toward which the head is turned; while on the other hand, if the light is viewed but one second, the after image appears in the direction of the actual flame.

Münsterberg found that the eyes were unconsciously turned toward the direction where the flame was seen before the change in the second case while in the former they passively follow the motion of the head. The explanation given is as follows: "When I open my eyes and see a flame, this optical impression brings out the motor effect of fixing my eyes upon it—an effect which is the essential element in attention. When I turn my head with closed eyes this head movement acts as a stimulus to a motor reaction of the eyes. This second stimulus is, of course, the same whether I turn my head after twenty seconds or after one second. Now if this same stimulus brings out two so very different effects, it must be because the stimulus from the optical impression is different after twenty seconds and after one second. After one second the optical stimulus is stronger than the head-stimulus, and the eyes turn therefore toward the flame."

The experiments reported were made with a view to determine how the motor impulse to fixate the eyes upon an object varies with the quality of the impression and with the time of fixation. A black frame with an opening to receive the test objects was placed directly in front of the subject and 60 cm. distant. At a signal given by the kymograph the eyes are opened and fixed on the object. After an interval another signal is given at which the eyes are closed and the head is turned through 45 degrees as nearly as possible and the eyes are opened. Note is then made on a suitably arranged arc of the position of the head and the angular divergence of the eyes. It was,

[1]MUENSTERBERG and CAMPBELL. *Psycholog. Rev.* I, 5.

of course, necessary that the head movement should be a pure motor reflex with no previous visualization.

With practically the same head deviation the eyes describe an arc of 9 deg. after one second, 22 deg. after two seconds, 30 deg. after three seconds, and 39 deg. after four seconds. The longer the time the weaker the motor stimulus which tends to turn the closed eyes in the direction of the object. The decrease is quickest where the impression is simple. A card having nine pictures upon it after four seconds has the power to turn the eyes 16 deg. A curious exception is found in the addition of figures in which case the eyes turn nearly as far as the head. This is explained, however, as not due to the inferior motor power of the process but to its being so great as to prevent the head-movement from being made as a reflex. The calculation was so absorbing that the head motion could only be made by interrupting it and giving conscious attention to the effort. The authors think that the whole question of the psychophysics of attention is by this method opened to an untrammelled and profitable investigation.

C. L. H.

The Localization of Sound.[1]

The question of auditory localization has always been perplexing and the various theories accounting for it are more or less unsatisfactory. Stumpf suggested that localization depends upon a difference of some sort between the sensations of the two ears. Preyer supposes that the semi-circular canals discriminate impressions from different directions. Others think this discrimination is simply an act of judgement based on the difference of intensity of sound in the two ears.

Münsterberg suggests that the sense of direction depends on a combination of sensation of sound and sensations of movement.

For the reinvestigation of the facts in the case an ingenious series of experiments was instituted. A horizontal circular zone and arcs of similar curvature which could be adjusted to any position on the horizontal arc, were contrived to carry telephones of equal intensity and quality. 0° means in front of the subject, whose head was supported in the centre of the arcs; 90°r at the right, 180° behind, etc. The answer was always given in degrees by the subject before opening the eyes.

1. When two symmetrcially placed sounds were heard they were

[1]MUENSTERBERG and PIERCE. *Psych. Rev.*, I, 5.

always located either at 0° or 180°; many individual variations occur.

2. When sounds are produced on both sides in unsymmetrical positions the results are inconstant. For any given point in either of the two quadrants on one side of the median plane, a point can be found in *each* of the two quadrants on the opposite side which in combination with the first will give localization in the median plane at 0° or 180°.

3. For symmetrically placed sounds, one of which varied in intensity by increasing the radial distance of the sounder, the subjective sound passed from 0° or 180° to 90° right or left as the case might be.

4. When both sounds are on one side in the horizontal plane the resultant may be located either before or behind. When the sounds are at 0° or 180° the resultant may be at 0° or 180°, usually at 0°, but it is not true that weak sounds are preferably placed behind.

5. When the attention was fixed on a given point and a single sound was produced the latter was subjectively displaced in the direction of the point of fixation.

6. When the muscles of one side are strained by voluntary effort the result is a tendency to locate that side farther to the rear.

7. When one ear has been fatigued by continued functioning no influence was discovered in most cases on the localization.

The authors conclude that these experiments (only part of which are noted here) indicate that no conscious relation of the tones to either ear exists, that sensations of touch play no part, that there is not a judgement of the difference of intensities in the two ears. On the other hand, many things show that sensations of movement are to be regarded as the psychological basis of the auditory spacial perceptions. It seems at first contradictory to deny the comparison of sound intensities and yet appeal to discriminative motions which must be based on such comparison, yet the authors believe that the difference in the physiological excitation of the two ears conditions the motor impulses with which the head reacts to the sound. These motor impulses seem to form a rather superfluous *Deus ex machina*. In order to determine whether the semi-circular canals contain the mechanism for establishing the postulated reflexes, the whole apparatus was fastened to a rotating disc. Sounds were usually displaced in the direction opposite to the rotation. If the eyes were closed and the sound was produced after the rotation ceased the displacement was in the direction of the rotation. The displacement in other words, in both cases was in the direction of the compensatory impulses to movements of the head.

The last mentioned experiments certainly add considerable probability to the theory that localization of auditory impressions consists in the addition to them of sensations of movement.

C. L. H.

The Cortical Centre of the Muscular Sense.[1]

Dr. Starr offers a singular case in evidence that the centre of the muscular sense is distinct from the centres of movement. It is regarded as settled that any defect in the tract conveying muscular sense from the muscles to the brain cortex will produce a disturbance in the power of coordination. Hitherto facts have been wanting to determine the actual position of this tract in the cortex and the exact location of the muscular sense centres. The following observation illustrates the possibility of producing an entire loss of muscular sense by a limited destruction of the brain cortex, without prod ucing at the same time any disturbance of motor power or tactile sensibility, and determines the localization of the muscular sense centre for the hand in the parietal region.

The patient, a young man, suffered with intense headache, to the left of, and somewhat behind the vertex, and from epilepsy. A heavy fall during his fifth year, injured his head and was followed by unconsciousness for several hours. Since the accident, while intelligence and memory were good, he was easily agitated and subject to emotional excitement and passion and lacked in power of application. At the age of sixteen he had another fall on his head resulting in an aggravation of these symptoms. With the accerbations of the headache a maniacal condition was produced. These attacks occurred at frequent intervals during five years. He was trephined at the seat of injury and a small vascular tumor about three fourths inch in diameter was found upon the surface of the brain. Some exploratory perforations were made and the wound made a rapid recovery, but immediately after the operation it was found that he had lost the muscular sense in the right hand below the elbow, all voluntary guidance of the hand being imperfect. The strength of the hand was unimpaired. With eyes closed he could not determine the position of the hand, yet tactile sense and temperature sense as well as that of pain were normal. After three months the muscular sense was fully recovered, it was therefore considered that this particular effect was produced by a

---

[1]STARR, M. A. The Muscular Sense and its Location in the Brain Cortex. *Psychological Review*, II, 1.

small localized injury in the cortex about two inches behind the fissure of Rolando and about an inch and a half to the left of the median line, at about the junction of the superior and inferior parietal lobules.

It seems to the reviewer that the case cited does not fully justify us in accepting the conclusion reached by the author in his closing paragraph: "This observation would therefore indicate: first, that the muscular sense centres are distinct in their location from tactile or pain or temperature sense centres; and also from the motor centres; secondly, that they are situated just behind the motor area in the parietal region of the brain." It seems much more probable that the injuries incidental to the operation or exploratory perforations impaired the tracts passing from sensory to motor centres. This would not destroy the sensation but might interfere with its normal operation upon the correlated motor centre.

C. L. H.

Sensations of Taste.[1]

The electric, metallic and alkaline tastes being reserved for special investigations, the present work treats only of those sensations recognised as special qualities, viz., sweet, sour, salt and bitter. The taste-substances used were: chlornatr., muriatic acid, sacch. alb, sacch., quin. sulph., and quin. pur. In all cases in which chemical combination of these substances was to be strictly avoided quin. sulph. and not quin. pur. was used. The greatest possible chemical purity was sought for these substances, which were dissolved in distilled water. The application was made partly by means of dropping-glass tubes on which a scale graduated by $\frac{1}{10}$ cm. was engraved, partly by means of soft pointed hair brushes. All disturbing accompanying sensations, not excepting that of temperature, were excluded. The simplest way to accomplish the last was to raise the fluids to be applied to the temperature of the mouth, viz. 37° C. Between the separate experiments the mouth was rinsed out with pure water of the same temperature, 37° C. After having trained the subjects, I first examined the cavity of the mouth, with a view to determining what parts were receptive of sensations of taste. These experiments were performed both on children and on adults. Taking into consideration

[1] *Contributions to the Physiological Psychology of the Sense of Taste.* FRIEDRICH KIESOW. Author's abstract of papers in Philosophische Studien, Bd. X, Heft 3, pp. 329 ff; Heft 4, pp. 523 ff; quoted from *Psychological Review*, II, 1.

what former investigators have found out the total results of this chapter will be given.

1. Besides the whole surface of the tongue together with its base and the under surface of its tip—the hard and soft palate, without doubt the arcus glosso-palatinus, the tonsils, the uvula, the isthmus faucium, the inside of the epiglottis and the mucous membrane of the cheeks participate in the sensation of taste.

2. All these parts are sensitive in childhood ; in adults the mucous membrane of the cheeks, the middle of the tongue and, with a few exceptions, the hard palate lose their sensitiveness. In some cases the under surface of the tip of the tongue on both side of the frenulum remains receptive also in adults.

3. The presence of disturbance is accounted for, sometimes by an affection of the cavity of the tympanum, sometimes by individual differences.

It must be remarked that the perceptive faculty of the inner epiglottis was established by Michelson and Langendorff,[1] that of the mucous membrane of the cheeks in childhood by Urbantschitsch.[2] Concerning the retrogression of certain taste surfaces in adults I must refer the reader to my longer article in which an explanation according to the theory of development is offered and literary references given.

In a further investigation I tested the sensitiveness of the different perceptive parts of the cavity of the mouth, by taking as measure the absolute given for the different qualities of taste, obtaining in this way the following general results :

1. Sensitiveness varies for the different qualities on the different parts of the tongue. Sweet is tasted best on the tip of the tongue, sour on the edge, and bitter at the base, acid equally on the tip and edges, but less at the base.

2. With regard the the values found in an isolated case for the other taste-surfaces, the sensitiveness for sweet and bitter appears in the following order: Soft palate, arcus glosso-palatin., uvula, under-surface of the tip; for sour, arcus glosso-palat., palat. molle, uvula, under-surface of the tip ; for salt, palatum molle, under-surface of the tip, arcus glosso-pal., uvula. The values are in part considerably

[1]Centralblatt für Physiol. 1892. P. 204.

[2]Urbantschitsch, *Beobachtungen über Anomalien des Geschmacks, etc.*, *in Forge von Erkrankungen der Taukenhöhle.* 1876.—I desire to draw special attention to this interesting work.

below those noted under 1. Only on the soft palate does salt reach the normal given.

3. A single investigation showed that in childhood all parts, excepting the tip and edges of the tongue, possessed nearly the same sensitiveness with regard to sweet. The tip and edges were more sensitive.

4. The explanation of the normal condition, as of individual differences is without doubt to be found in the law of adaptation, excepting those cases in which pathological causes, obstructions, etc., appear.

Further, attention was directed to the qualitative conditions of the sensations of taste. These experiments were only made on adults. First, I was enabled to prove that all four above-named qualtities are true sensations of taste, also that the sensations of sour and salt must not be excluded from the sphere of taste on account of the accompanying tactile sensations. On the contrary, my investigations led to the conclusion that all our perceptions of taste are accompanied by tactile sensations, although in different degrees. Sweet is accompanied on and near the limen by a sensation of smoothness, at higher intensity by that of slipperiness, at very great intensity by that of scratching and biting. The liminal values of bitter are accompanied by a distinct sensation of greasiness. Even the application of distilled water produced with some of my subjects a distinct perception of taste. Two of them tasted water on the tip of the tongue as sweet, on the edges as sour and sourish, at the base bitter. Others tasted it as bitter in the whole cavity of the mouth, others only bitter at the base and tasteless on the other parts of the tongue. The bitter sensation produced by distilled water accompanied the single sensation called forth by taste—substances often for a time above the limen, so that in this way two sensations arose which I have designated as double-sensations. Even a mechanical stimulus of the base of the tongue with a glass rod produced with me and with many of my subjects a sensation distinctly bitter.

Great influence in the region of taste must be ascribed to association and the effects of contrast. The conditions of contrast I investigated with special care ; the total results of which may be given concisely as follows :

1. Contrasting stimuli must be recognized in the sense of taste.

2. Salt contrasts with sweet, salt with sour, sweet with sour.

3. Salt and sweet, and salt and sour contrast both on simultaneous stimulation of corresponding parts of the tongue and on succes-

sive stimulation of the same taste-surface. The contrasts of sweet and sour could only be observed in the latter case.

4. Bitter forms an exception, but yet perhaps gives rise to contrasts restricted to individuals.

Studies from the Yale Psychological Laboratory.

The second volume of these studies was issued in November last. The first article by Professor Scripture, On Mean Values for Direct Measurements, devotes 40 pages to a technical mathematical discussion largely concerned with the median as an instrument in psychological research.

The second paper, Researches on the Mental and Physical Development of School Children, by J. Allen Gilbert, details the results of a series of tests made upon about a hundred children from 6 to 17 years of age, each child being tested in the following respects: muscle-sense, sensitiveness to color-differences, force of suggestion, voluntary motor ability, fatigue, weight, height, lung-capacity, reaction-time, discrimination time, and time-memory.

The results of the first test give in grams the threshold for discrimination to weight for each child. There is a gradual increase in ability to discriminate from the ages of 6 to 13, which is tolerably uniform except for a temporary abrupt falling off for boys at 11. The sensibility is strongly diminished for girls at 13 and for boys at 14, after which it slowly increases. The curves of color discrimination are far more irregular.

The force of suggestion was studied along lines similar to those followed by Dressler, as published last year in the American Journal of Psychology (cf. review in this Journal, Vol. IV, p. cxxxii), though with slightly different apparatus and some difference in the results. Of blocks equal in weight, but differing in size the smallest were always judged the heaviest, the girls making greater errors than the boys. Dresslar found this illusion to be stronger in bright children than in dull and stronger in adults than in children. On the other hand, Gilbert finds the illusion to increase up to nine years, then to diminish to puberty, increasing slightly until 15 years old for boys and 16 years for girls, after which it again diminished to 17 years.

The voluntary motor ability was estimated by counting the number of taps which a child can make in 5 seconds. Boys tap more rapidly than girls and both show a diminished rate at puberty.

The average reaction-time of all ages for bright children was 20.7 hundredths of a second; for those of average ability it was 21.3;

for dull children 22.4. The curve for girls is more irregular than that for boys and boys were quicker than girls throughout. The same is true of the curve of the discrimination-time for red and blue.

In these and other experiments cited there is usually a very striking fluctuation in the curves at the age of 7 and another always at puberty. It is also deduced that puberty has a greater effect on the mental than on the physical aspects of man's nature. The development of girls is far more seriously affected by periodic changes than that of boys. In all the curves involving a time element there is a marked loss in ability from 6 to 7. Between 11 and 12, just before puberty, in both curves the bright and dull children act with about the same rapidity, though both before and after that age the dull ones are much slower than the bright ones. The child is judged dull at 13 because he is unable to act as quickly.

This investigation is one of the most comprehensive and thorough thus far published and the author has laid all educators, as well as the psychologists, under great obligations.

The volume contains several other papers, among which may be mentioned one by Professor Scripture entitled, A Psychological Method of Determing the Blind-Spot, of especial importance as emphasiz- the fact that psychological measurements are not necessarily purely physical or physiological. As purely mental facts the phenomena of consciousness may be measured by one another with an accuracy rapidly approaching that of physics.

C. J. H.

Functional Distribution of Motor Roots.[1]

This is an experimental study of dogs, cats and rabbits for the precise determination of the functional relations of the motor roots of the spinal cord. Tables are given showing the motor reactions after stimulation of the several roots and the following conclusions are presented:

1. The innervation of the limbs presents from the very beginning of the medullary origin an evident systematization. The systematization is functional; that is, the motor fibres that issue from the medulla at a given level are distributed to synergic muscular groups, and concur there in an associated movement.

---

[1]POLIMANTI, OSVALDO. Sulla Distribuzione funzionale delle Radici motrici nei Muscoli degli Arti. Ricerche sperimentali. *Lo Sperimentale*, XLVIII, 3, 1894.

2. This associated movement is always complete; that is, it corresponds to the execution of a given function.

3. It is for this reason that, by the excitation of a single root, there come into play muscles of antagonistic action (e. g. extensor and flexor, abductor and adductor), which, however, concur in a combined movement, which will result in the execution of an exceedingly complex act, such as leaping, habitual or voluntary.

4. The fact is worthy of note that by the excitation of roots which correspond and which have an equal or almost equal distribution in the different animals, precisely the same results are not obtained, so far as concerns the function.

5. These results stand in direct relation with the instincts and with the habits of the animal experimented upon. For example, by the excitation of the second sacral root are obtained in the dog wagging movements of the tail, movements which the animal executes when it is satisfied or wants to be merry. We may therefore, call it *the joy-root.* In the cat, however, by excitation of the same root is obtained that attitude of the tail which the animal assumes in moments of anger. Considering now the instincts of the dog and the cat we explain the difference, and thus other examples might be cited.

6. Nor do the differences concern only diversity of function, but always intensity too, in our opinion in proportion to the instincts and habits of different animals. Thus, for example, the roots which upon excitation give that complex of muscular actions necessary for leaping (II^{a} lumbar in the dog and IV^{a} lumbar in the cat) are capable of developing, even if excited with a current of equal force, a reaction of very different intensity ; most intense in the cat (an animal especially given to leaping), much less so in the dog.

7. From this one might be led to think that by hereditary tendency and by the habits or exercise of the muscle there may become established functional conditions such as would have for their object to facilitate and render more efficacious the influence of the higher centres ; that moreover here is explained how not only certain instinctive acts, but also some others which would appear to us of a psychic order may be developed even independently of cerebral influence.

8. The functional distribution of the motor roots has great importance from the physiological and clinical point of view. In normal cases this explains to us how the action of the centres is manifested in a manner so rapid and well regulated ; in pathological cases this explains to us how there is possible in some cases the paralysis or the

paresis of a function without having the paralysis of a well defined muscular group.

The author promises to extend these studies to other animals also, especially to the monkeys.

G. F. MC KIBBEN.

New Studies on the Pons Varolii.[1]

The methods of Golgi and Weigert applied to the dog, the cat, the Guinea pig, the mouse and the white rat led to the following conclusion about the pons.

1. The pons is the place of origin for the greater part of the fibres constituting the middle cerebellar peduncles; these fibres penetrate the white substance of the cerebellum and then go into the cortex of the cerebellar lamellae, where they consitute perhaps the ascending fibres.

2.. The medulla is also formed by axis cylinders from the cells of Purkinje, which after having crossed the median line and taking a more or less vertical course, direct some longitudinal fibres into the reticular substance of the opposite side.

3. These facts, together with the existence of collaterals in the medulla from the pyramidal tract, throw some light upon the influence of the cerebrum upon the cerebellum. Suppose, for example, that the cerebrum sends along the pyramidal tract a voluntary motor impulse to the muscles. This impulse, having reached the level of the medulla, will pass in part through the pyramidal collaterals and the fibres of bulbar origin up to the cerebellum. There it will excite the cells of Purkinje and those subordinate to them to add to the motor impulse a coordinating nervous current which will reach the motor niduli of the medulla and cord, perhaps by way of the second kind of bulbar fibres, perhaps by the corpus restiforme, or perhaps by the descending cerebellar fibres of Marchi of the antero-lateral columns. From this it results that the cerebellum receives information of every voluntary motor impulse and its cooperation is necessary for the precise execution and coordination of movements.

4. The pyramidal tract is in connection by means of its collaterals with different grey centres of the encephalon and cord. For example, with the cells of the striata through the collaterals of the small fibres of the internal capsule; with the substantia nigra of Soemmering through other collaterals from the superior part of the peduncles, with the cells of the pons and consequenrly with the cortex of

---

[1]CAJAL, S. R. Le Pont de Varole. *Bibliogr. Anat.*, II, 6 Dec., 1894.

the cerebellum through the bulbar collaterals, and, finally, with all the motor niduli of the medulla and spinal cord.

The Histology of the Infundibular Region.

Dr. Berkley has collected his previous papers on this subject and presented them, together with some new matter, in a richly illustrated monograph appearing in the Winter number of *Brain* for 1894. One of the most interesting results of these studies is the light thrown upon the structure and relations of the neurolglia cells in adult brains. Earlier writers have supposed that the embryonic supporting substance of the brain and spinal cord—the ependymal neuroglia—almost entirely atrophies and disappears in the adult mammal. Dr. Berkley finds, however, several varieties of ependymal neuroglia cells extending from all portions of the middle and inferior regions of the cavity of the third ventricle, and reaching to the periphery, all portions, bodies, branches, tentacles, being readily distinguishable. Such structures are not, then, confined to embryonic brains or adult reptiles, amphibians and fishes, and their importance as constituents of the so-called gelatinous tracts becomes more and more evident.

Accessory Parietal Eyes in Anguis fragilis.[1]

This is a preliminary notice of the results of an investigation carried on under the auspices of the Elizabeth Thompson foundation. The most interesting results are those concerned with the variability of the organ.

1. The number of cases of accessory parietal eyes is only a little less in embryos of the blind worm than the cases of the absence of these structures. The presence of an accessory parietal eye is then an extremely frequent anomaly with the embryos.

2. Exceptionally there is found in the same individual two and even three accessory eyes.

3. These eyes are generally out of the medial plane of the head. According to their situation with reference to adjacent organs we may distinguish; Interparieto-epiphysial eyes, situated between the epiphysis and the principal eye, the most frequent; epiphysial eyes, joined to or incorporated with the epiphysis; intraparietal eyes, included within the principal parietal eye; choroid eyes, next to the

[1] PRENANT, A. Les yeux pariétaux accessoires d'Anguis fragilis sous le rapport de leur situation, de leur nombre et de leur fréquence. *Bibliogr. Anat.*, II, 6, Dec., 1894.

plexus choroideus, exceptional. The exact figures upon which the conclusions as to variability are based are given in the subjoined table.

Total number of embryos examined	47
" " " cases of certain absence	25
" " " " " presence	20
" " " doubtful cases (added to the positive cases in the rest of the table)	2
Total number of accessory eyes observed (including the doubtful cases and two cases of double eyes and two cases of triple eyes)	28
Interparieto-epiphysial eyes	16
Epiphysial eyes	7
Interparietal eyes	4
Choroid eye	1

Any criticisms of the morphological value of these eyes should be reserved until the author's final paper appears. But whatever this significance may be, this extreme variability certainly has its significance. This is another and a very interesting case illustrating the extreme variability so often found in organs which are either degenerate or which for any other reason may be undergoing retardation or acceleration in the phylogenetic development.

C. J. H.

The Antennary Auditory Organ of Insects [1]

The first account of the auditory organ of the mosquito seems to be that of Johnston, who in 1855 described a pair of pyriform capsules between the eyes from which spring the antennæ. "The space between the inner and outer walls of the capsule, which we may confidently term the auditory capsule, is filled with a fluid of moderate consistency, opalescent, and containing minute spherical corpuscles, and which probably bears the same relation to the nerve as does the lymph in the scalæ of the cochlea of higher animals. The nerve itself of the antenna proceeds from the first or cerebral ganglion, advances toward the pedicle of the capsule in company with the large trachea which sends its ramifications throughout the entire apparatus, and, penetrtaing the pedicle, its filaments divide into two portions." Johnston sought to show that the long hairs of the antennæ are graduated to respond to sonant vibrations of different lengths. Mayer studied the organ in living insects and observed the vibration of cer-

[1] CHILD, C. M. Ein bisher wenig beachtetes antennales Sinnesorgan der Insecten. *Zeitsch. Wiss. Zool.*, LVIII, 3.

tain hairs in consonance with given tones. The author of the present paper gives a detailed account of the structure and development but adds nothing of importance upon the functions. He accepts the evidence for the auditory nature of the apparatus but concludes that it was originally adapted simply for tactile sensation and may still retain, in part at least, the original function.

We reproduce part of the authors' summary. "In most orders of insects there is in the second joint of the antennæ a highly developed sensory organ. This organ consists essentially of ganglion cells, which are produced into long rod-like processes or are connected by threads with rods. The rods terminate either in pores of the skin of the joint between the second and third segments or in chitinous processes of the peripheral margin. In many of the culicidæ and chirononidæ the organ is greatly developed, while in the female the structure is simpler and more nearly approaches the type. This greater development in the male indicates a relation to the sexual life. The proton of Johnston's organ in the larva of cuculidæ and chirononidæ first appears as a ring-like fold of the hypodermal invaginated antennary tube near the base of the head. Out of this fold are formed the ganglion cells and rods, the latter by the fusion of cells."

C. L. H.

RECENT LITERATURE.

ADAMKIEWICZ. Zu Flechsig's Mitteilung: Ueber ein neues Einteilungsprincip der Grosshirnoberfläche. *Neurol. Cent.*, XIII, 22.

ALBANESE, M. Ueber die Anordnung der motorischen Nervenfassern für die Flexoren und Extensoren in den Nervenstämmen des Frosches. *A. exper. Path. u. Pharmak.*, XXXIV, 5-6, 1894.

ALLEN, EDGAR J. Studies on the nervous System of Crustacea. (1) Some Nerve-Elements of the Embryonic Lobster. (2) The stomato-gastric System of Astacus and Homarus. (3) On the Beading of Nerve Fibres and on End-Swellings. *Quart. Jour. Micr. Sc.*, XXXVI, N. S. No. 144.

ANDRIEZEN, W. LLOYD. On Some of the Newer Aspects of the Pathology of Insanity. *Brain*, LXVIII, Winter, 1894.

ARNSTEIN, C. Zur Morphologie der Sekretorischen Nervenendapparate. *Anat. Anz.*, X, 13, 4 Feb., 1895.

ASHER, L. Ueber Mittelohrentzundung nach Trigeminusresection. *Beiträge zur klin. Chirurgie red. von P. Bruns*, 1893.

AZOULAY, L. Préparations du Système nerveux colorées par deux méthodes nouvelles: 1st acide osmique et tannin; 2d vanadate d'ammoniaque et tannin. *Bul. Soc. Anat. de Paris*, 5 ser., VIII, 26, Dec., 1894.

BASCH, K. Die centrale Innervation der Saugbewegungen. *Jahrb. f. Kinderheilk.*, XXXVIII, 1.

v. BECHTEREW, W. Die sensiblen Bahnen im Rückenmark. Nach den Untersuchungen von F. Holzinger. *Neurol. Cent.*, XIII, 18.

v. BECHTEREW, W. Ueber pupillenverengernde Fasern. *Neurol. Cent.*, XIII, 22.

BENEDIKT, M. L'anatomie comparée du lobe pariéto-temporal. *Arch. ital. de biol.*, XXII, 1, 1894.

BENHAM, W. BLAXLAND. A Description of the Cerebral Convolutions of the Chimpanzee known as Sally, with notes on the Convolutions of other Chimpanzees and of two Orangs. *Quart. Jour. Micr. Sc.*, XXXIII, 1, N. S. No. 145, 1894. 5 pl.

BERKLEY, HENRY J. The Finer Anatomy of the Infundibular Region of the Cerebrum including the Pituitary Gland. *Brain*, LXVIII, Winter, 1894.

ST. BERNHEIMER. Das Wurzelgebiet des Oculomotorius beim Menschen. 4 colored plates. *Wiesbaden, J. F. Bergmann*, 1894.

BETHE, ALBRECHT. Die Nervenendigungen im Gaumen und in der Zunge des Frosches. *Archiv Mik. Anat.*, XXIV, 2, Nov., 1894. 2 pl.

BINET, A. Contribution à l'étude du système nerveux sous-intestinal des insects. *Jour. anat. et phys.*, XXX, 5, 1894. 4 pl.

BOMBARDA, MIGUEL. La conscience dans les crises epileptiques. *Rev. Neurologique*, II, 23, Dec., 1894.

BOTTAZZI, F. Ueber die Hemisection des Rückenmarkes bei Hunden. *Cent. f. Physiol.*, VIII, 17, Nov., 1894.

BOYCE, R. Beitrag zur Lehre von der absteigenden Degeneration in Gehirn und Rückenmark und Bemerkungen über die Localization und die Leitunsbahnen der krämpfe bei der "Absynth-Epilepsie." *Neurol. Cent.*, XIII, p. 466. 5 figs.

BRUCE, LEWIS C. Notes on a Case of Dual Brain Action. *Brain*, LXIX, Spring, 1895.

BULLOCH, WM. The Central Nervous System of an Anencephalous Fœtus. *Jour. Anat. and Phys.*, XXIX, N. S. IX, 2, Jan., 1895.

BURCH, G. J. and HILL, L. E. On d'Arsonval's physical theory of the negative variation. *Jour. of Physiol.*, XVI, 5-6.

CADEAC and GUINARD. Quelques remarques sur le role du thymus chez les sujets atteints d'une altération du corps thyroide ou éthyroidés. *Soc. de Biol.*; 16 June, 1894.

CAJAL, S. RAMON. Le Pont de Varole. *Bibliographie Anat.*, II, 6, Dec., 1894.

CAJAL, S. RAMON. Estructura del ganglio de la habenula de los mamiferos. *Anal. soc. espan. d. hist. nat.*, Ser. 2, III (23), 1894.

CAJAL S. RAMON. Algunas contribuciones al conocimiento de los ganglios des encéfalo. *Anal. soc. espan. d. hist. nat.*, Ser. 2, III (23), 1894.

CANNIEN, A. Recherches morphologiques sur le nerf auditif. *Ann. malad. oreille, larynx*, XX, pp. 694-708.

CAROUSINE. Sur l'isolement de différents systèmes de faisceaux dans le moelle épinière par la méthode embryologique. *La Méd. moderne*, 1894, No. 31.

CHEVREL, R. Recherches anatomiques sur le système nerveux grand sympathique de l'esturgeon (acipenser sturio). *Arch. de zool. expér.*, 1894, No. 3, 1 pl.

CHIPAULT, A. Chiurgie opératoire du système nerveux. Tome premier: Chiurgie cranio-cérébrale. *Paris, Rueff et cie*, 1894.

CIRINCIONE. Méthode pour déterminer le poids et le volume des substances grise et blanche du cerveau. *Riforma med.*, 1894.

CLAUS, C. Bemerkungen über die Nervenendigungen in den Hautsinnesorganen der Arthropoden, insbesondere crustaceen. *Zool. Anz.*, XVII, 461.

COLLINGE, WALTER EDWARD. The Sensory Canal of Fishes. I. Ganoides. *Quart. Jour. Micr. Sc.*, XXXVI, 4, N. S. No. 144, 2 pl.

CONSIGLIO, M. Sulle fibre motrici dello stomaco nel tronco del vago. *Sperimentale, sez. biol., Firenze*, XLVIII, pp. 58-118.

COYNE and CANNIEN. Note sur la structure de la membrane de Corti, *Jour. méd. de Bordeaux*, XXIV, pp. 304-306.

DANA, CHAS. L. The Localization of Cutaneous and Muscular Sensations and Memories. A Study of the Functions of the Motor Area of the Cortex of the Brain. *Jour. Nerv. and Mental Disease*, XXI, 12, Dec., 1894.

DARVAS. Ueber das Nervensystem eines Anencephalus, vergleichen mit dem Nervensystem normales Neugeborener. *Verh. Anat. Ges. Strassburg*, VIII, 1894.

DEJERINE, J. Anatomie des Centres Nerveux. Tome premier: Méthodes

générales d'étude; Embryogénie; Histogénèse et Histologie; Anatomie du Cerveau, 401 figs., 45 in colors. *Paris*, Rueffet Cie., 1895.

DOGIEL. Die Betheiligung der Nerven an den Schwankungen in der Pupillenweite. *Pflüger's Archiv f. ges. Physiol.*, LVI, p. 500.

ENGELMANN, TH. W. Die Blätterschicht der Elektrischen Organe von Raja in ihren genetischen Beziehungen zur quergestreiften Muskelsubstanz. *Pflüger's Arch. f. Physiol.*, LVII, p. 149.

EWALD. Zur Physiologie des Labyrinths, Mittheilung; Das Hören der labyrinthlösen Tauben. *Pflüger's Archiv*, LIX, pp. 258-275, *Bonn*, 1894.

FAWCETT, EDWARD. An Unusual Mode and Site of Termination of the Right Sacral Sympathetic Cord. *Jour. Anat. and Phys.*, XXIX, N. S. IX, 2, Jan., 1895.

FERE, CH. Note de psychologie morbide comparée: L'immobilité du cheval. *Rev. Neurol.*, III, 2, Jan., 1895.

FERRIER, DAVID and TURNER, W. ALDREN. A Record of Experiments illustrative of the Symptomology and Degenerations following Lesions of the Cerebellum and and its Peduncles and Related Structures in Monkeys. *Philos. Trans.*, B, 107, 1894.

FLECHSIG, P. Ueber ein neues Eintheilungsprincip der Grosshirnoberfläche. *Neurol. Cent.*, XIII, p. 674, 1894.

FOREL, A. Gehirn und Seele. *Wien. med. Z.*, XXXIX, 40-44, 1894.

FRANCOIS-FRANCK. Recherches sur l'innervation vaso-motrice du pénis. Méthodes appliquées à l'étude de l'innervation vasomotrice pénienne. Topographie des nerfs vasodilateurs péniens. Topographie des nerfs vasoconstricteurs péniens. *C. R. Soc. biol.*, Ser. 10, I, 30, 1894.

v. FREY, M. Beiträge zur Physiologie des Schmerzsinnes. *Ber. k. Sächs. Ges. d. Wiss. Leipzig*, 2 July, 1894.

FRIEDLAENDER, B. Altes und Neues zur Histologie des Bauchstranges des Regenwurmes. *Zeits. wiss. Zool.*, LVIII, 4.

FUCHS, SIGMUND. Einige Beobachtungen an den elektrischen Nerven von Torpedo ocellata. *Cent. f. Physiol.*, VIII, 17, Nov,, 1894.

GLEY. Sur la suppléance supposée de la glande thyroide par le thymus. *Soc. de Biol.*, 23 June, 1894.

GLOGNER, MAX. Die Schwankungen der elektrichen Reizbarkeit der peripherichen Nerven bei Beri-Berikranken. *Archiv f. path. Anat. u. Phys.*, CXXXV, 1, 1894.

GOODALL, EDWIN. The Microscopical Examination of the Human Brain. *London*, 1894, 186 pp.

GRABOWER. Ueber die Kerne und Wurzeln des N. accessorius und N. vagus und deren gegenseitige Beziehungen; ein Beitrag zum Studium der Innervation des Kehlkopfs. *A. Laryn. u. Rhinol.*, II, 2, 1894.

GREEFF, RICHARD. Die Spinnenzellen (Neurogliazellen) im Sehnerv und in der Retina. *Arch. Augenhk.*, XXIX, 3-4, 1895.

GROSSMANN, M. Ueber den Ursprung der Hemmungsnerven des Herzens. *A. ges. Physiol.*, LIX, 1-2.

GRUETZNER, P. Einige neuere Ergebnisse aus dem Gebiete der Sinnesphysiologie. *Deutsche Med. Woch.*, XXI, 5, 31 Jan., 1895.

HENSCHEN, S. G. Sur les centres optiques cérébraux. *Revue gén. d'ophth.*, XIII, 8.

HERRICK, C. JUDSON. The Cranial Nerves of Amblystoma punctatum. *Jour. Comp. Neurol.*, IV, Dec., 1894. 2 pl.

HERRICK, C. L. The Seat of Consciousness. *Jour. Comp. Neurol.*, IV, Dec., 1894.

HERZEN, M. A. Suture nerveuse. *Rev. scientifique*, 22 Sept., 1894.

HEYMANS, J. F. and DEMOOR, L. Etude de l'innervation du coeur des vertébrés à l'aide de la méthode de Golgi. *Mem. couronnès et autr. mém. publ. par l'ac. R. de méd. de Belgique. Collection in 8vo.*, XIII, 5, 1894, 55 pp., 25 pl.

HIS, WM. Ueber die Vorstufen der Gehirn- und der Kopfbildung bei Wirbelthieren. *Archiv f. Anat. u. Phys.*, *Anat. Abt.*, 1894, 5-6.

HIS, WM. Sonderung und Charakteristik der Entwickelungsstufen junger Selachierembryonen. *Archiv f. Anat. u. Phys.*, *Anat. Abt.*, 1894, 5-6.

HOCHSTETTER, F. Ueber die Beziehung des Thalamus opticus zum Seitenventrikel der Grosshirnhemisphären. *Anat. Anz.*, X, 9, 19 Dec., 1894.

HODGE, C. F. and AIKINS, H. AUSTIN. The Daily Life of a Protozoan : a Study in Comparative Psycho-physiology. *Am. Jour. Psych.*, VI, 4, Jan., 1895.

HOLZINGER, F. Die sensiblen Bahnen in Rückenmark. *Neurol. Cent.*, 1894, No. 18.

HOORWEG, J. L. Ueber die Nervenerregungen durch Condensator entladungen. *Pflüger's Archiv f. ges. Physiol.*, LVII, p. 427.

ISERGIN, P. Die Innervation der Zungengefässe. *Arch. f. Anat. u. Phys.*, *Phys. Abt.*, 1894, 5-6.

JOUBIN, L. Nouvelles recherches sur l'apparail lumineux des céphalopodes du genre Histioteuthis. *Bull. Soc. scient. et méd. de l'Ouest*, III, 3, 1894.

KAES, TH. Beiträge zur Kenntniss des Reichtums der Grosshirnrinde des Menschen an markhaltigen Nervenfasern. *Inaug.-Diss. München*, 1894.

KEITH, ARTHUR. Growth of Brain in Men and Monkeys, a short Criticism of the usual Methods of Stating Brain-Ratios. *Jour. Anat. and Phys.*, XXIX, N. S. IX, 2, Jan., 1895.

KIESEL, A. Untersuchungen zur Physiologie der facettirten Auges. *Sitzb. kais. Akad. Wiss. Math.-Naturwiss. Classe, Wien*, Bd. CIII, Heft I-IV, Abt. 3, April, 1894.

KLAM, A. C. Bijdrage tot de kennis van het vezel verloop in den pedunculus cerebri. Inaug.-Diss, *Leiden*, 97 pp., 8 vo.

KLEINENBERG, N. Sur le développement du système nerveux périphérique chez les mollusques. *Arch. ital. de biol.*, XXII, 1, 1894.

KOCH, J. L. A. Das Nervenleben des Menschen, in guten und bösen Tagen. *Ravensburg, Otto Maier*, 1895.

v. KOELLIKER, A. Ueber den Fornix longus von Forel und die Riechstrahlungen im Gehirn des Kaninchens. *Verh. Anat. Ges. Strassburg*, VIII, 1894.

v. KOELLIKER, A. Ueber die feinere Anatomie und die physiologie Bedeutung des sympathischen Nervensystems. *Vhdlgn. Ges. deutsch. Naturf. u. Aerzte*, 66 , *Vers. Wien*, I, pp. 97-120 , *Wien. klin. Woch.*, VII, 40-41 ; *Wien. med. Blätter* XVII, 41-42 ; *Münch. med. Woch.*, XLI, 41-42; *Wien. med. Woch.*, XLIV, 41.

KRAUSS, WM. C. The Histological Conformation of the Medulla. *Jour. Nervous and Ment. Disease*, N. S. XX, 1, Jan., 1895.

KREIDL, ALOIS. Die Wurzelfasern der motorischen Nerven des Oesophagus. *A. ges. Physiol.*, LIX, 1-2.

LAMBERT, M. La résistance des nerfs à la fatique. *Paris, G. Carré*, 1894.

LANGENDORFF, H. O. Ciliarganglion und Oculomotorius. *Pflüger's Arch. f. Physiol.*, LVI, p. 522.

LANGLEY, J. N. and ANDERSON, H. K. The Constituents of the hypogastric Nerves. *Jour. Physiol.*, XVII, 3-4.

LANGLEY, J. N. Further Observations on the secretory and vasomotor fibres of the foot of the cat with notes on other sympathetic nerve fibres. *Jour. Physiol.*, XVII, 3-4.

LAPINSKY, M. Ueber den normalen Bau und pathologische Veränderungen der feinsten Gehirncapillaren. *Arch. Psychiat. u. Nervenkrankh.*, XXVI, 3, 1894.

v. LENHOSSEK, M. Der feinere Bau des Nervensystems im Lichte neuester Forschungen. 2. gänzl. umgearb. Aufl. *Berlin*, 1895.

v. LENHOSSEK, M. Zur Kenntnis der Netzhaut der Cephalopoden. *Zeits. wiss. Zool*,, LVIII, 4.

LEYDIG, F. Integument und Hautsinnesorgane der Knochenfische, Weitere Beiträge. *Zool. Jbr., Abt. f. Anat. u. Ontogen.*, VIII, 1. 152 pp.

LOEWENTHAL, N. Ueber eigenthümliche Zellengebilde im Sympathicus des Frosches. *Monats. Anat. u. Physiol.*, XI, 9.

LUBINOFF. Le retour á l'état normal des cellules nerveuses pathologiquement modifiées. *La Méd. Mod.*, 1894, No. 28.

LUI, AURELIO. Observations on the Histological Development of the Cerebellar Cortex in Relation to Locomotion. Prefatory Note. *Alienist and Neurologist*, XVI, 1, Jan., 1895.

LUYS, J. Du développement compensateur de certaines régions encephaliques en rapport avec l'arret du dèveloppement de certaines autres, *Ann. de psychiat. et d'hypnol.*, N. S. IV, pp, 193-196.

MAAS, O. Präparate aus der Entwickelung des Hummers (Nervensystem). *Vhdlg. deutsch. Zool. Ges. München*, p. 95.

MAHAIM, A. Recherches sur la structure anatomique du noyau rouge et ses connexions avec le pédoncule cérébelleux supérieur. *Brussels, Hayez*, 1894, 44 pp.

MANZ, WM. Ueber markhaltige Nerverfasern in der menschlichen Netzhaut. *A. Augenhk.*, XXIII, 3-4, 1894. 2 pl.

MARTIN, P. Bogenfurche und Balkenentwickelung bei der Katze. *Jenaische Z. Naturw.*, XXIX, N. F., XXII, 2, 1895.

MAYSER. Ueber den Nervus opticus der Taube. *Allg. Zeits. Psychiat.*, LI, 2. 2 plates.

MERCIER, A. A propos d'une nouvelle méthode de fixation (le liquide de Zenker). *Bibliographie Anat.*, II, 6, Dec., 1895.

MILLS, C. K. The Naming Centre, with the Report of a Case Indicating its Location in the Temporal Lobe. *Jour. Nerv. and Mental Disease*, N. S. XX, 1, Jan., 1894.

MINGAZZINI, G. Sur la signification physiologique des dégénérescences

provenant d'extirpations hémi-cérébelleuses. *Arch. ital. de biol.*, XXII, 1, 1894.

MINK, ARTHUR E. Psychiatry and Brain Localization. *Alienist and Neurologist*, XV, 4, Oct., 1894.

MORAT, J. P. Qu'est-ce qu'un centre nerveux? *Rev. scient.*, 1894, No. 21.

MOTT, F. W. Experimental Inquiry upon the afferent Tracts of the Central Nervous System of the Monkey. *Brain*, LXIX, Spring, 1895.

MOTT, F. W. A Case of Amyotrophic Lateral Sclerosis with Degeneration of the Motor Path from the Cortex to the Periphery. *Brain*, LXIX, Spring, 1895.

NAGEL, W. A. Beobachtungen über den Lichtsinn augenloser Muscheln. *Biolog. Centralbl.*, XIV, 11, p. 385.

NAGEL, WILIB. Vergleichend-physiologische und anatomische Untersuchungen über den Geruchs- und Geschmacksinn und ihre Organe mit einleitenden Betrachtungen aus der allgemein vergleichenden Sinnesphysiologie. *Bibliotheca Zoolog.*, XVIII. 1. 1 pl.

NISSL. Bernhard von Gudden's hirnanatomische Experimental-untersuchungen. Zusammengefasst dargestellt. *Allg. Zeits. f. Psych. u. psych.-gericht. Med.*, LI, 3.

NUSSBAUM, M. Nerv und Muskel: Abhängigkeit des Muskelwachstums vom Nervenverlauf. *Verh. Anat. Ges. Strassburg*, VIII, 1894.

OLIVER, CHARLES A. A Short Note upon so-called "Hereditary Optic-Nerve Atrophy"—as a Contribution to the Question of Transmission of Structural Peculiarity. *Proc. Am. Phil. Soc.*, XXXII, 143, May, 1893.

ORRU, E. Ueber die Nervenendigungen im Haar. *Untersuchungen zur Naturlehre d. Menschen und Tiere*, XV, 3. 1 pl.

PALADINO, G. Sur les limites précises entre la névroglie et les éléments nerveux dans la moelle épinière, et sur quelques-unes des questions histo-physiologiques qui s'y rapportent. *Arch. ital. de biol.*, XXII, 1, 1894.

PALADINO, G. Contribution aux connaissance sur le mode de se comporter des racines dorsales dans la moelle épinière et sur les effets consécutifs à leur résection. *Arch. ital. de biol.*, XXII, 1, 1894.

PHISALIX, C. Nouvelles recherches sur les chromatophores des céphalopodes (centres inhibitoires du mouvement des taches pigmentaires). *Arch. de Physiol.*, VI, 1, 1894.

PINKUS, F. Die Hirnnerven des Protopterus annectens. Aus. d. anat. Inst. d. Univ. Freiburg i. B. *Morph. Arbeit.*, IV, 2, 1894.

PRENANT, A. Les yeux pariétaux accessoires d'Anguis fragilis, sous le rapport de leur situation, de leur nombre et de leur fréquence. Résultats prélim. *Bibliographie Anat.*, II, 6, Dec., 1894.

RABL-RUECKHARD, H. Noch ein Wort an Herrn Studnicka. *Anat. Anz.*, X, 7.

RABL-RUECKHARD, H. Einiges über das Gehirn der Riesenschlange. *Zeits. wiss. Zool.*, LVIII, 4.

RAUGE, P. L'infundibulum et les orifices des sinus. *Ann. d. malad. de l'oreille, du larynx, etc. Paris*, XX, pp. 476-492.

REINER, M. and SCHNITZLER, J. Ueber die Abflusswege des liquor cerebrospinalis. Sep.-Abdr. aus *S. Stricker "Fragmente aus der experimentellen-Pathologie," Wien*, 1894.

REYNOLDS, ERNEST S. On the Condition of the Reflexes in Total Transverse Division of the Spinal Cord (with a Critical Digest). *Brain*, LXIX, Spring, 1895.

ROBINSON, BYRON. The cervical Ganglion of the Uterus. *Med. Record*, XLVI, 13, 1895.

ROSIN. Demonstration einer neuen Fārbungsmethode des Nervensystems nebst Bemerkungen über Ganglienzellen und Gliazellen. *A. Psych. u. Nervenkrankh.*, XXVI, 3, 1894.

RUEDINGER, N. Ueber die Hirne verschiedener Hunderassen—Uber die Hirne von Zwillingen.—Die Bildung und der Bau des Glaskörpes. *Verh. Anat. Ges. Strassburg*, VIII, 1894.

RUSSELL, J. S. RISIEN. Experimental Researches into the Functions of the Cerebellum. *Philos. Trans.*, B. 109, 1894.

RUSSELL, J. S. RISIEN. Defective Development of the Central Nervous System in a Cat. *Brain*, LXIX, Spring, 1895.

SCHAPER, ALFRED. Einige kritische Bemerkungen zu Lugaro's Aufsatz: "Ueber die Histogenese der Körner der Kleinhirnrinde." *Anat. Anz.*, X, 13, 4 Feb., 1895.

SCHEPILOFF, CATHERINE. Recherches sur les nerfs de la VIII. paire crânienne et sur les fonctions du cerveau et de la moelle chez les grenouilles. Avec un aperçu comparatif des fonctions de système nerveux central dans la classe des Batraciens. *Arch. sc. phys. et. natur.*, S. 3, XXXII, 8.

SCHIFF and HERZEN, A. Sur le rétablissement fonctionnel dans le domaine des nerfs conpés. *Rev. Scientifique*, 17 Nov., 1894.

SCHIMAMURA, S. Ueber die Blutversorgung der Pons- und Hirnschenkelgegend, insbesondere des Oculomotoriuskerns. *Neurol. Cent*,, XIII, 19 and 21.

SEDGWICK, ADAM. On the Inadequacy of the Cellular Theory of Dvelopment and on the Early Development of Nerves, particularly of the third nerve and of the sympathetic in Elasmobranchii. *Quart. Jour. Micr. Sci.*, XXXVII, 1, 1895.

SHAW, JAMES. Contribution to the Clinico-Pathological Study of Cerebral Localization. *Brain*, LXIX, Spring, 1895.

SHERRINGTON, C. S. On the anatomical Constitution of Nerves of Skeletal Musles; with Remarks on Recurrent Fibres in the Central Spinal Nerve-root. *Jour. of Physiol.*, XVII, 3-4, 3 pl.

SMIRNOFF. Terminaisons nerveuses libres dans l'épithélium du ver de terre (lumbricus) en russe. *Messager neurologique de Bechterew*, II, 3, 1894.

SMITH, G. ELLIOTT. Preliminary Communication on the cerebral Commissures of the Mammalia, with especial Reference to Monotremata and Marsupialia. *Pr. Linn. Soc. N- S. Wales*, Oct. 31, 1894. (Abstract.)

SPENCER, W. G. The Effect produced upon Respiration by Faradic Excitation of the Cerebrum in the Monkey, Dog, Cat and Rabbit. *Philos. Trans.*, B. 104, 1894.

STUDNICKA, F. K. Zur Geschichte des "Cortex cerebri." *Verh. Anat. Ges. Strassburg*, VIII, 1894.

TAGLIANI, G. Ricerche anatomiche intorno alla midolla spinale dell' Orthagoriscus mola. *Mon. Zool. ital.*, V, 11, 1894.

TEPLIACHINE. Recherches sur les nerfs secretoires de la glande lachrymale. *Arch. d'opthal.* 1894, No. 7.

TISCHERNISCHOFF, S. P. Zur Topographie der weissen und grauen Substanz des Rückenmark bei angeborener Abwesenheit der Extremitäten und bei partieller Anencephalie. *Archiv f. Anat u. Phys. Anat. Abt.*, 1894, 5-6.

TOMPKINS, H. A case of sensory aphasia accompanied by word deafness, word blindness and agraphia. *Brit. Med. Jour.*, No. 1739. 1894.

TURNER, W. A. and BULLOCH, W. Observations upon the Central Relations of the Vago-Glossopharyngeal, Vago-Accessory and Hypoglossal Nerves, from the Study of a Case of Bulbar Paralysis. *Brain*, LXVIII, Winter, 1894.

TURNER, WM. ALDREN. On the Central Connections and Relations of Certain Cranial Nerves. *Brit. Med. Jour.*, No. 1760, p. 643.

VANLAIR, M. C. Suture nerveuse et restauration fonctionnelle. *Rev. Scientifique*, 4 Aug., 1894.

VAS, F. Das Verhältnis des Nervus vagus und Nervus accessorius zum Herzen. Experim. Studie mit 4 Taf. *Physiol. Stud. am Instit. d. Univ. Budapest. Wiesbaden*, 1895.

WALDEYER, W. Ueber einige anthropologisch bemerkenswerthe Befunde an Negergehirnen. *Sb. K. Preuss. Ak. Wiss.*, 1894, No. 51.

WEINLAND, ERNST. Ueber die Functionen der verschiedenen Teile des menschlichen Gehörorganes, vom anatomischen Standpunkte aus betrachtet. *A. Ohrenhk.*, XXXVII, 3-4.

WERNICKE, C. Grundriss der Psychiatrie in klinischen Vorlesungen. Theil I: Psycho-physiologische Einleitung. *Leipzig, G. Thieme*, 1894.

RECENT LITERATURE.

The Cerebral Commissures.

The homologies of the commissural systems of the cerebrum are confessedly perplexing, and we must welcome any attempt to remove the existing obscurity. The chief occasion of ambiguity seems to be the question of definition. It is especially the callosum which lacks determinateness.

In the higher mammals there is, of course, no difficulty in recognizing that body, but the moment one searches for the familiar band in marsupials or non-mammals the difficulty is apparent. Recent comparative studies have thrown into greater prominence the hippocampal commissure and emphasized the close relation between it and the callosum.

Those who have recently contended for the existence of a callosum in lower groups, among whom the writer is numbered, have done so on the understanding that a mantle commissure cephalad of, and in the same horizontal plane as the hippocampal commissure must be the homologue of the callosum. It is, of course, recognized by all that the greater relative extent of the osmatic centres in the lower animals renders mistake easy in locating homologous areas.

Dr. A. Meyer has attempted to limit the entension of the word callosum.[1] Meyer would reserve the name callosum "for the anatomically well delimited commissural system of that region which gives origin to the genuine corona radiata, the fibres of the internal capsule." With this understanding the marsupials and, of course, all lower vertebrates have no callosum.

Naturally Osborn has to bear the brunt of the criticism, for he has expressly said that the callosum is composed of a cephalic or frontal portion which supplies the dorso-median part of the mantle and the commissure of the Ammon's horn. Meyer lays great stress on the absence of the inner capsule. Edinger indeed applies this name to certain fibres passing through the median wall to the brain base. The

---

[1]Zur Homologie der Fornixcommissur und des Septum lucidum bei den Reptilien und Saeugern. *Anat. Anzeiger*, X, 15.

true coronal fibres, however, pass through the lateral walls and the fibres mentioned by Edinger are, according to Meyer, really fornix fibres. To this it may be said that Edinger has recognized the fornix tract and that the changes in the form of the ventricle in the various groups are so great that it must be relied on with caution in morphological determinations. It is a little strange that Meyer is apparently ignorant of the fact that the writer has given detailed descriptions of the hippocampal commissure in a wide range of non-mammals and traced the descending fibres of the fornix in reptiles and even fishes several years ago. We do not see that because the peduncular fibres have not differentiated in the lower forms as they have in the higher mammals it follows that there can be no homologue of the callosum. This is but another illustration of the effects of too close reliance on anthropotomy, and reminds one of the remark once made to the writer by a rising neurologist who said with an air of conviction, "But for me, don't you know, the callosum must describe an arc—must be a beam connecting something." The allusion was of course to the root meaning of "trabs" or "Balkan."

On the other hand the facts seem to us to fully justify the second point made in the paper before us, i.e., that the septum is not an atrophied cortical region but a part of the ganglionic base. This is made more probable by the fact that this region, which, to avoid prejudice we have called *intraventricular lobe*, in the reptilian and amphibian brain, has a structure quite unlike that of true cortex.

In a recent paper, G. Elliot Smith has discussed the same problem from a somewhat different stand-point. [1]

We are left in the dark as to the criteria relied on by Smith to distinguish the callosum, though he says that "it seems possible that the corpus callosum appears in response to the demand for a shorter connecting route between the rapidly developing dorsal portions of the cortex cerebri." The intraventricular lobe or septum of reptiles the author terms the *precommissural area*, objecting to the term septum that the latter in higher mammals is merely the thickened lamina terinalis. This area is a part of the rhinencephalon and accordingly the commissural fibres passing through it cannot be callosal.

Part of the anterior commissure is said to be the homologue of the callosum, for it is characteristic of the objectors to the evident homologies to strain at the gnat but swallow the camel. Still we have

---

[1]Preliminary Communication upon the Cerebral Commissures of the Mammalia. *Proceed. Lin. Soc. N. S. Wales*, Oct., 1894.

no reason to complain, for the hippocampal commissure itself is "merely a part of the anterior commissure, which has been separated off earlier in the phylogeny." In the placental mammal the anterior part of the hippocampns is represented by the gyrus supracallosus with the indusium. We are glad to note that especial emphasis is laid on the fact that the fasia dentata is essentially supracallosal. We wish to deprecate the writer's tendency to confuse superficial structures (gyres) with internal elements (tracts) which, even when they become substantially coextensive, stand in the relation of form and substance.

The same writer has recently contributed a paper to the Anatomischer Anzeiger[1] on the connection between the olfactory bulb and the hippocampus in which he combats the idea that the external radix of the olfactory reaches the hippocampus, as was stated by Edinger. "The fibres of the external olfactory tract arise as axis cylinder processes of the 'mitral cells' of the olfactory and terminate by means of collaterals and end branchings in relation with the protoplasmic processes of the cells of the pyriform lobe and olfactory tract." The evidence is apparently conclusive that part of these fibres do so end; indeed it has been recognized by the writer. In the fishes the tract enters the homologue of the pyriform; the question being whether some of the fibres do not continue into the hippocampus, as they certainly seem to do in the lower forms. In Ornithorhynchus the intraventricular lobe, or precommissural area, together with the lamina and the quadrilateral area, form an intermediary station between the olfactory lobe and the hippocampus. The axis cylinder processes of some of these cells pass dorsad and may extend in the alveus to the extremity of the hippocampus. Others enter the fimbria and still others cross in the hippocampal commissure. Above these fibres, in the intraventricular lobe is a compact bundle of fibres which enter the fasia dentata and fimbria. In placental mammals it is probable that this olfactory bundle of the fasia dentata runs in the striæ Lancisii.

C. L. H.

The Brain of Desmognathus.[2]

Though the morphological importance of the amphibian brain has long been recognized by reason of the critical taxonomic position occupied by the group, yet, aside from matters of external form, most

[1] *Anat. Anz.*, X, 15.

[2] Fish, Pierre A. The Central Nervous System of Desmognathus fusca. *Jour. Morph.*, X, 1, 1895.

of the careful descriptive work done in this field has been surprisingly barren of morphological fruit. This is no doubt largely due to the fact suggested by Professor Fish that the older methods are ill adapted to differentiate the histological elements of these primitive brains. It is a matter of familiar observation that methods well adapted to bring out the details of a mammalian, reptilian or fish brain may leave the amphibian tissue apparently a structureless mass of white and grey matter. It is gratifying, therefore, to observe that this field is now being assiduously cultivated by the aid of newer methods which promise better things for the future.

That the amphibian brain is the most primitive or generalized type among the Craniota has been maintained by several of our ablest neurologists on the basis of general form and topography. That the same would prove true of the histological structure has long been suspected but the lack of acurate knowledge of the details of cellular structure and fibrous distribution has prevented safe generalization. This of course applies to the Urodela more especially, rather than to the Anura, where considerable diversity of structure has already been demonstrated. Professor Fish's careful description of the cellular and fibrous elements of Desmognathus as demontrated by the methods of Golgi and Weigert will be a valuable aid in all future morphological work. He considers the unipolar cells lying next to the endyma to be the primitive type of neuroblastic element and that the processes are exclusively cellifugal. One fibre of finer caliber than the others of the dendridic mass separates from the latter as the neurite or axis-cylinder process. Farther towards the periphery, this neurite arises from the very base of the dendridic process or from the cell body, while the most peripheral cells are distinctly bipolar, the neurite and the dendrite being at opposite ends. It is conceivable, we may add, that this arrangement is correlated with the diffuse distribution of the cellular elements and the relatively feeble development of the longitudinal fibre systems, the functions of the latter being perhaps largely carried on by the diffuse dendridic reticulum constituting the greater part of the white matter. In order that cellipetal impulses may pass from the white matter to the cells lying next the endyma the dendrites of the latter must be directed peripherally through the outer layers of nerve cells. As the cellifugal neurite must pass in the same direction, it is quite natural they should pass out together for part of their course, forming a neurodendrite. Although Professor Fish decides against this view, I see no reason why we may not assume that the dendrites are cellipetal here, as in other cases. When, however, such

cells migrate toward the periphery the natural polarity asserts itself and the cells become elongated tangentially to the brain surface and typically bipolar or else stomach-shaped, the cellipetal fibres and the cellifugal fibres joining the cells at right angles to each other.

The fibre tracts are partly myelinic and partly amyelinic, the latter being confined to the prosencephalon and the most of the diencephalon, and represented by the precommissure, callosum, supracommissure, Meynert's bundle and a portion of the peduncular tracts.

We quote the first paragraph of the authors summary. "The preservation of so many embryological features both in the morphology and histology of the neuraxis of the *Desmognathus* is quite remarkable. Throughout the whole length of the tube there may be recognized the homology of the three layers as described by His. In the early embryo the ental layer is composed of epithelium, or endyma; the middle or mantle layer consists of the cinerea, and the ectal layer of alba. The nerve cells appear to be scarcely more than fairly well developed neuroblasts. The regeneration of lost parts in the Urodeles is well known, and this phenomenon may be more or less dependent upon the embryonic condition of the elements of the neuraxis and their power of rapid growth utilized in this direction." This goes far to substantiate the view previously expressed in the columns of this Journal that the Urodela are *permanent larvæ* so far as the essential points of cerebral structure are concerned. While this makes it necessary to use some caution in deducing phylogenetic considerations, it by no means minimizes their importance to phylogeny.

The other features in Professor Fish's paper we cannot dwell upon, but commend the whole as a welcome contribution to a difficult subject. C. J. H.

The Paraphysis.[1]

In a brief paper Studnicka reviews the current morphological teachings about the paraphysis and endeavors to show that in Petromyzon the anterior parietal organ has nothing to do with the paraphysis. The anterior parietal and the pineal may be regarded as serially homologous sensory organs, but the paraphysis has no such function, nor is there evidence that it has ever had such. The author reiterates the belief that the anterior organ is homologous with the parietal eye of saurians. The paraphysis in Petromyzon lies well forward of the

[1]STUDNICKA, F. K. Zur Anatomie der sog. Paraphyse des Wirbelthiergehirns. *Sitzb. k. böhm. Ges. der Wissenschaften, Prag*, 1895.

anterior parietal organ and in teleosts of the *zirbelpolster* and in both cases is strictly membranous like the other parts of the tela choroidea.

C. J. H.

The Formation of the Central Canal of the Nervous System of Teleosts.[1]

Evidence is submitted to show that the central nervous system in teleosts, unlike that of that of the other vertebrates, originates as a solid cord instead of a tube. There is then a rapid multiplication of cells with karyokinesis in the middle of the cord, as a result of which large intercellular spaces are formed which ultimately fuse to form the central canal.

Changes in Nerve Cells During Functional Activity.[2]

An investigation along lines suggested by Hodge and Vas upon the superior cervical sympathetic ganglia of the rabbit, motor areas of the cerebrum of the dog, the lumbar region of the spinal cord of the dog, also the retina and visual centres of the dog. The conclusions are:

1. That *during rest* several chromatic materials are stored up in the nerve cell and that these materials are used used up by it during the performance of its function.

2. That *activity* is accompanied by an increase in size of the cells, the neuclei and the nucleoli of the sympathetic, ordinary motor and sensory ganglion cells.

3. That *fatigue* of the nerve cell is accompanied by shrivelling of the nucleus and probably also of the cell and by the formation of a diffuse chromatic material in the nucleus.

Details of the technique are given in the paper.

The Pathology of Insanity.[3]

This comprehensive paper is one of the best illustrations of the application of the method of comparative anatomy to pathology which has thus far appeared. An exhaustive resume of the newest and best

---

[1] ROUDNEW, W. Note sur la formation du canal dans le système nerveux central des téléostéens. *Bibl. Anat.*, III, 1, Feb. 1895.

[2] MANN, GUSTAV. Histological Changes induced in Sympathetic, Motor and Sensory Nerve Cells by Functional Activity. Preliminary Note. 1 pl. *Jour. Anat. and Phys.*, XXIX, N.S. IX, 1, Oct. 1894.

[3] ANDRIEZEN, W. LLOYD. On Some of the newer Aspects of the Pathology of Insanity. *Brain*, LXVIII, Winter, 1894, pp. 548-693.

that recent methods has taught us of the cellular structure of the nervous system of man and other vertebrates serves as a basis for conclusions as to the pathology of the various insanities. While lack of space forbids an adequate abstract of these conclusions, we call attention to the paper as one which neither the morphologist, the psychologist, nor the pathologist can afford to ignore.

C. J. H.

Psychological Bibliographies.

The question of a general scientific bibliography is now receiving more attention gerhaps than ever before, and apparently with greater promise of a practical result before the close of the century. But in the mean time the separate disciplines are endeavoring in a more or less desultory way to extricate themselves from the accumulated products of their own activity by means of bibliographies, book-lists and indexes. Within the departments of Psychology and Neurology the number of such publications has been increased during the past year by the addition of two annuals, "The Psychological Index" issued by the Psychological Review, and "L'Année Psychologique" from the Sorbonne laboratory by Beaunis and Binet (Paris, F. Alcan).

The Psychological Index is compiled by Howard C. Warren and Livingston Farrand and contains 1312 titles. It is, for American students at least, doubtless the most useful list published. The sections devoted to neurological topics are far from complete. This, perhaps was to have been expected, though just what was the principle of selection is hard to discover. The other sections are very complete and fairly well arranged. An index of authors concludes the volume.

L'Année Psychologique is a bulky volume of 600 pages containing, besides the bibliography proper (1217 titles), other matters of general psychological interest. The first 250 pages are devoted to original papers, mostly from the Paris laboratory, concluding with an elaborate descriptive article on the psychological laboratories of America. The 280 pages of the second part are devoted to reviews and abstracts of the more important papers of the year. Illustrations are freely employed and the abstracts are sufficiently full to be of great value. A brief necrology is added. The bibliographical list comprising the third part is otherwise so valuable that it seems the more unfortunate to find that the titles are all translated into French. If this is necessary for the benefit of some of the French readers, the original titles should certainly be given also. Thus the value of the

work would be greatly enhanced to the French constituency, as well as to others, and we shall hope to see this change made in the subsequent issues of this annual.

C. J. H.

Mental Development of the Child.[1]

No one can seriously doubt that the golden age of children is approaching, for a thousand tokens bear unmistakable witness that the king is coming to his own and that the father of the man is soon to to take that proverbial preeminence he has long held only in theory. Begin where you will it is the same; formerly the prospective mother was enveloped during that mystic period by an impenetrable mist of muslin which was symbolic of an esoteric cult with its peculiar language and worshipers. Now all this changed and the mother elect is found deep in Darwin, Preyer, Egger, Max Müller and Fröbel. Now, instead of "flounces," it will be "sensorimotor association" that is wafted to your ears as you are bundled over the threshold.

When the helpless "subject" appears, the mother is distracted between her duties as correspondent of the new society for scientific child study and the claims of twenty different antiseptic nursing bottles.

Unhappy the child whose first random incoherencies have no adequate record in some one of the many "life records!" Even if the latter are not made as obligatory as a certificate of vaccination by the "Boards" of the future, certainly lack of such a credential will be taken as conclusive evidence that the child was not "well born."

In all seriousness and in spite of its frequent crudeness, the attemps at a systematic study of the early psychical manifestions of the child are among the most encouraging indications, not only in psychology but also and especially in pedagogy. It is true, as the author of the book immediately before us says, that "only the physiologist can observe the child, and he must be so saturated with the information and his theories that the conduct of the child becomes instinct with meaning for his theories of mind and body." We may hope, however, that the combination "mother and physiologist" may not prove altogether chimerical and, even where this ideal is not reached, we may still believe, also with the author, "that all faithful recording is of importance."

---

[1] Mental Development in the Child and the Race. Methods and Processes. By James Mark Baldwin, *Macmillan and Co.* 1895.

Professor Baldwin's book, as it stands, might be properly called "Essays toward a Genetic Psychology." A *System* of Psychology it is not, chiefly because of the way the subject grew upon its author's hands as related in his preface. Those will be disappointed who are led by the title to expect something complete in the way of directions for child study or results of such study; what they may find, if capable of appropriating the materials, is a means of self-preparation for elaborating an original system based on evolutionary principles. The horizon broadens as one proceeds and though the psychologist may find comparatively little that is new and may groan somewhat at the "rachet-motion" by which he is compelled to progress, he can hardly fail to be impressed with the fact that a genetic or evolutionary psychology is coming which does not find it necessary to rule out the psychical in its adhesion to the biological. To our mind the great value of the book lies in the emphatic teaching that the conscious elements, pleasure and pain, are primitive and by no means identical—that there is, in other words, a central initiative so that the organism is never a passive object reacting under external stimuli.

We fully sympathize with the author's remark, "That most vicious and Philistine attempt in some quarters to put science in the straight-jacket of barren observation, to draw the life-blood of all science—speculative advance into the secrets of things—this ultra-positivistic cry has come here as everywhere else, and put a ban upon theory. On the contrary, give us theories, theories, always theories. . . . In the matter of experimenting with children, therefore, our theories must guide our work." Again, against the cautious deprecation of child experimentation, Professor Baldwin aptly replies: "Experiment? Every time we send a child out of the home to the school we subject him to experimentation of the most serious and alarming kind. He goes into the hands of a teacher who is not only not wise unto the child's salvation, but who is, on the contrary, a machine for administering a single experiment to an infinite variety of children. It is perfectly certain that two in every three children are irretrievably damaged or hindered in their mental and moral development in the school."

So far as appears, however, the author's chief contribution to the experimental department so ably championed consists in the further elaboration of a so-called "dynamogenic method," that is, a method whose resuits shall be in terms of the most fundamental motor reactions of the infant. The hand movements are, of course, the most satisfactory. "The facts that the most motile organs have acutest

sensibility, notably the fingers; that certain marked types of action, such as imitation, arise first in connection with the hand; that the central organic preparation for volition is secured first in the arrangements for hand movements; all these facts indicate that the hand movements are the best index of general and special sensibility in the infant." Irrespective of any theory of the origin of volition, the author holds that for a long period the sensations which are stimuli to movement become "effort stimuli"—the thing is a thing of sensational dynamogeny or suggestion.

Incidentally, in stating a formula for the dynamic influence of stimuli, we are cautioned very truly that most appeals to mathematics are an artificial show of exactness—a proposition for which readers of modern German psychology may well be grateful.

The theory of dynamogeny is illustrated in the fields of colour vision and the origin of writing, after which the author proceeds at once to the development of his genetic theory. For this purpose it is of fundamental importance to define suggestion, which is for him "the removal of inhibitions to movement by a certain condition of consciousness."

The following definitions will indicate the position taken:

1. *Physiological suggestion* is the tendency of a reflex or secondary automatic process to get itself associated with and influenced by stimulating processes of a physiological and vaguely sensory sort.

2. *Sensorimotor* and *ideo motor suggestion* is the tendency of all nervous reactions to adapt themselves to new stimulations, both sensory and ideal, in such a way as to be more ready for the repetition or continuance of these stimulations.

3. *Deliberative suggestion* is the tendency of different competing sensory processes to merge in a single conscious state with a single motor reaction, illustrating the principle of nervous summation and arrests.

4. *Imitative suggestion* is the tendency of a sensory or ideal process to maintain itself by such an adaptation of its discharges that they reinstate in turn new stimulations of the same kind.

Habit and accommodation thus become the two important facts of the nascent psychical life, one providing for the repetition of what is worth repeating the other for the adaptation of the organism to new conditions. The fundamental question is then, "where and how does the remarkable power of selection arise." Granting the law of dynamogenesis, the author answers: "the life-history of organisms involves from the start the presence of the organic analogue of the he-

donic consciousness," in other words there is the element of feeling to be recognized from the first.

In passing, we may note the definition of emotion growing out of the discussion. "Pleasure and pain of accommodation, plus pleasure and pain of habit, plus a certain lot of qualities contributed to consciousness by more or less habitual processes of muscle, organ, and gland, going on at the time."

We cannot follow the discussion into details which the reader familiar with the previous works of the author may anticipate in a measure. It is sufficient to repeat that the perusal of the book will prove suggestive to all careful readers.

C. L. H.

Psychology of Childhood.[1]

The demand for an adequate theory of psychogenesis has been so long-standing and so urgent that we wonder not so much at the present zeal with which observations and experiments are being pushed along this line as at the fact that this development has been so long retarded. Since comparative psychology and child-psychology now have the field and promise to hold it for some time to come, the appearance of several excellent manuals designed to guide subsequent students is a real advantage not only to these students themselves but to their science. In the department of child-psychology Mr. Tracy's work will spare the beginner much of the tedious bibliographical drudgery and should at the same time so equip him as to produce results more coherent in themselves and more easily assimilable into the body of the science than much which has preceded. He has presented us in 170 pages with a fairly complete account of the best observations thus far made on *infant* psychology, without, however, extending it to children of school age. The work is, as suggested in the introduction, more than a compilation. The matter is well digested and is unified by a sound psychological principle. The author's psychology is conservative and no new or startling theories are advanced. In fact the chief value of the book lies in this absence of all 'special pleading.'

In discussing memory on page 68 the question is asked, Which of the senses furnishes the most vivid and lasting memory-images? The muscular sense is regarded as of paramount importance here. Noth-

[1]TRACY, FREDERICK. The Psychology of Childhood. 2d Ed. *Boston, D. C. Heath and Co.*, 1894.

ing is said in this connection of the role of emotion. In my own experience this seems to be the dominant factor, as regards the lasting qualities, at least; for my earliest memories all lead back to moments of strong feeling.

The sections on Conception and Reasoning would have been clarified, it seems to me, by applying to the child the distinction between perceptual and conceptual processes, or 'intelligence' and 'reason,' as used by Professor Morgan in his Animal Life and Intelligence.

The chapter on Language is probably the most valuable in the book and should prove of interest to the philologists.

Finally, it should be added that the style is easy and free from technicalities so that any intelligent person may avail himself of the facts presented without special psychological training.

C. J. H.

Intellectual States in Melancholia.[1]

This is a study of the associations of ideas in melancholia. Of the four types of the disease—melancholia with consciousness, depressive melancholia, anxious melancholia, and melancholia with stupor—the first two only were studied.

Cases of melancholia are in general tracable to two causes,—first and most frequently to a general (but unknown) somatic condition which manifests itself as an affective state in consciousness and about which the ideas are associated in a secondary way, and second and less often to a fixed idea, or obsession, which occasions the affective state, about which in turn the other intellectual states are secondarily associated.

Both in melancholia and in abulia these associated ideas obey always one law, the *law of synthesis*. The patient being unable to give a valid account for his depression, which is nevertheless a fact of real experience, finds himself under the necessity of inventing reasons for it. It is this which shapes the whole mental life of the patient.

Looking for the cause of melancholia to profound and widespread organic changes, we find here an explanation for the general psychic relaxation so characteristic of melancholia. The increase of the inhibitory phenomena and the resultant abulia may be traced to the same cause. The invasion of consciousness affects all of the men-

[1]DUMAS, GEORGES. Les états intellectuels dans la mélancolie. *Paris, Felix Alcan*, 1895.

tal faculties, but not to the same extent. The synthetic activities are weakened with the others but not so much, so that the law of synthesis referred to above fills the whole field of consciousness and dominates all else.

Accepting the Lange-James theory of the somatic origin of emotion as probably true, the author erects upon it a theory for the etiology of melancholia. Cases belonging to the first category (of somatic origin) are the expression of a cachexia which is usually found to be a sequella of some one of the infectious fevers, though other origins are also common. Melancholia of the second type (of intellectual origin) is explained in a similar way. An idea or a mental shock may act upon the body (via the circulatory system, as suggested by Meynert's theory of emotion) in such a way as to produce a psychical depression essentially similar to that found in the cases of the first type. From this, as before, arises not melancholia, but a melancholic condition.

It follows then that melancholia has no existence as a mental entity, but may be resolved into sensory processes, on the one hand, on the other hand, into phenomena of arrest.

Dr. Dumas' essay will prove of interest alike to pathologist and psychologist.

C. J. H.

Feeling and Thought.[1]

The work before us falls into two parts distinguished by the sources of their materials, (1) Morbid Psychology, (2) Normal Psychology. The pathological part part discusses in successive chapters mania, melancholia, hypochondria, extacy, chronic delirium. Of these the first four are, "considered by themselves, so to speak, symmetrical and exhibit separately all the elements of conscious life.' Mania is knowledge of the outer world, hypochondia of the organic, or bodily processes, isolated and deprived of all feeling content. Each is therefore a morbid exaggeration of thought. In melancholia and extacy, on the contrary, feeling is isolated and exaggerated to the exclusion of thought. In normal life feeling and thought each acts as a counterpoise keeping the other in equilibrium. When this equilibrium is destroyed by disease, feeling and thought are found to vary in inverse ratio, though no definate mathematical law is to be inferred from this form of expression.

---

[1]GODFERNAUX, ANDRE. Le sentiment et la pensée et leurs principaux aspects physiologiques. Essai dei psychologie expérimentale et comparée. *Paris. F. Alcan*, 1894, pp. xii + 225.

The stupor which marks the final stage of melancholia is regarded as a condition in which feeling exists in a pure state, dissociated from thought. The reviewer questions whether in such a case any form of consciousness whatever would be possible. It may well be doubted whether even the most typical and uncomplicated case of any one of these forms of alienation ever results in so perfect an isolation of the psychic factors as is here implied ; yet it is freely granted that such is their tendency and the author's principles, if not over-worked at the outset, may be of service to us in the sequel.

In Chronic delirium the author finds "a definate and constant succession of different affective states [1] corresponding to definate and constant modifications of the association of ideas ; such that the evolution may be the transcription or better the 'justification' of the affective states."

In the second part it is first shown that in normal life the same general relations prevail between feeling and thought as those so greatly exaggerated in pathology. The association of ideas is rarely normal and perfectly systematized. It constantly tends toward incoherences differing in degree only from those found in the types of mental alienation. Consciousness, in other words, is rarely in a state of equilibrium.

The author vigorously combats the popular idea that the association of ideas is a self-explanatory mechanism ; and he does more than most other critics, he puts a more sound idea in place of it. Those vague, unlocalized somatic prpcesses whose psychical equivalent is found in the "affective state" lie at the basis of most associations ; other are due to emotions.[2] The affective life, or "inner life" is the fluid medium upon which floats thought. Thought then (and this seems to the reviewer a *non sequitur*) grows out of feeling. This is true for the individual only, not for for the species. "If in the race, it is thought which produces feeling, since it is the external excitations easily registered in the organism which establish little by little the tendencies or emotions ; in the individual, on the contrary, it is feeling which produces thought, since it is only in obedience to hereditary

---

[1] "Affective state" is a term employed to designate feeling in its undifferentiated form ; regarded as corresponding in the motor realm to phenomena of excitation or depression.

[2] "Emotions," as defined by the author, are concrete, well-defined forms of feeling which arise when the somatic processes have been coordinated into tendencies.

tendencies that thought may arise and develop." It seems of doubtful propriety to regard either as derived from the other since both are probably primitive.

In conclusion, the author regards it as established that there is a constant and rigorous parallelism between the conscious life and the motor life and that the phenomena of consciousness act and react upon each other like the motor phenomena to which they correspond. While accepting many of the fundamental postulates of the newer monists and often adopting their phraseology, he maintains a strictly dualistic attitude throughout, quoting with approval Paulhan, "There are not a spiritual world and a material world acting upon each other; there is a parallelism between them and not reciprocal action."

While we should in many cases draw conclusions different from those of the author from the evidence presented, yet the book has much to commend it as a sincere and conservative attempt to solve some of the deeper psychological problems of today.

C. J. H.

The Standard Dictionary.

By courtesy of the publishers (Funk and Wagnalls Co., New York) we have placed upon our table a copy of the Standard Dictionary. While a critical review of philological principles would be out of place here, yet the work possesses some points of practical interest to the student and the author which merit notice. It claims to offer a layer vocabulary than any other English dictionary; and, while not a dictionary of technology, we have found the selection of technical terms in anatomy, physiology and medicine comprehensive and well-selected beyond our expectation. The large number of such terms admitted has been made possible by frequently grouping them in tables under the name of the specialty to which they belong, thus under *craniometry* over two hundred special terms are defined. The phonetic spellings recommended by the American Philological Association are given a place along with the current forms; the rules for the compounding of words are an advance upon anything which has thus far appeared, though the application of even these simple rules seems rather cumbersome; illustrations are very numerous and usually excellent. The full page color plates are worthy of special mention.

A convenience of the greatest practical value is the position of the definition, which immediately follows the vocabulary term. So also, the most common significance is placed first, the others following in order of usage; last of all the etymology, the quotations, deriv-

atives, phrases, synonyms, etc. The system of diacritical marks employed, the "scientific alphabet," may be confusing to many who know no language but English; but to all familiar with European languages, either ancient or modern, this difficulty will disappear, and in any case the gain in uniformity and precision more than compensates it.

There are many other new and original features, but the best of all is the evident thoroughness with which the work has been edited and the eminent ability enlisted in all departments. We regard the Standard Dictionary as the most satisfactory general dictionary of the English language thus far published.

LITERARY NOTICES.

The Present State of Comparative Psychology.[1]

One turns to this work with eagerness. The author is master of the rare art of expressing logical thought in perspicuous English and has already done much to lift the study of animal intelligence out of the vulgar rut in which it has so long laid. Has he perhaps at last discovered the key to the interpretation of the mental processes of animals for which we have been groping? Has he at least shown us how we may contribute toward this end and make our scattered observations acquire a scientific value? Unfortunately a negative answer must be given to both questions. But this is far from saying that there is not much of value in the book. Many familiar things are said in a brighter way and the reconstructed biological monism is ably expounded.

What the author in his prolegomena modestly calls a subordinate object, the discussion of the place of consciousness in nature, will, it is most likely, usurp a preeminent place in the minds of most readers.

Mr. Morgan's monism is analytic; for him the organism is one and indivisible, but is polarisable in analytic thought into a bodily and a mental or conscious aspect which, like object and subject, are distinguishable but not separable. One is as true as the other, the true reality is the union of them both.

Adopting Professor James' figure of a wave of consciousness, the physiological conditions of consciousness are discussed. As far as the body is concerned, all that it does or suffers belongs to the category of occurrences of the material world. Life is a coordinated sequence of transformations of energy. Accompanying some of these transformations of energy or molecular changes of the body are states of consciousness. These are psychical not physical states. The wave of consciousness constitutes the mind. According to this then the mind—the totality of the wave of consciousnes—does not exist apart from the conscious activity. There remain only organic vestiges or structural changes. For the monist the conscious is simply an aspect of the nervous. The important question is, How does a molecular change happen to have two aspects—what is meant by the word 'aspect,' under

[1] C. Lloyd Morgan. Introduction to Comparative Psychology. *Walter Scott, London.* Price six shillings.

whose specious covering what of fallacy may not hide? Can there be two aspects apart from two observers or two positions of the same observer, and is not a change of position as much a competent cause as a molecular vibration? Again, what is it whose position changes? Right here is an obscurity which any amount of prior or subsequent brilliance serves but to throw into stronger contrast. Frankly stated we have a dynamic realism, according to which force—activity— is all and in all. Matter is simply our interpretation of certain rates and figures of vibration. Our author recognizes subdominant nervous states whose intensity is suficient to bring them into consciousness, but no criterion is offered to determine the availability of one intensity rather than another for this important office nor are we helped to understand how such subconscious processes continue to exert an influence on the dominant ones. The discrimination of three methods of estimating the position of a given mind in the scale is, we think, useful and deserving a wider illustration than it received. The chapter on the sense impressions of animals is pleasing reading and contains interesting illustrative matter.

In the closing paragraph of the passage on automatism and control we are told that it is a suggestion unsupported by cerebral anatomy that there may be centres for the control of sensory activity. Perhaps the now well-attested existence of efferent fibres in the nerves of special sense will supply the author with at least a suggestion in this direction.

The reasons are given at length for denying to lower animals the power of perceiving relations or reasoning but as they consist chiefly in a sifting of evidence it is doubtful whether the result can be accepted as conclusive. It would seem to us that the hub of the matter lies in the question whether a given process in man or animals is to be identified with its subsequent explanation. There can be little doubt that all isolated mental processes in man may be performed independently of any formulation of them. What the man may do but the animal cannot do is to put that process explicitly in language. In denying reason to animals Morgan excludes implicit reasoning and limits the process to a recognition of the necessary relation of cause and effect.

Coming now to the core of the problem, our author admits that there is an orderly and determinate activity in consciousness without which the subject tumbles to pieces as an incoherent series of sensations with nothing to give them unity and to interpret them as a whole; he adds that so far from being dissimilar to anything else in the realm of existence, this selective synthetic activity in consciousness is but the subjective aspect of the selective synthetic activity which is objective

in the not-self. Here again we seem to be juggling with the phrase "subjective aspect." We have been taught to avoid the use of that to be defined in our definitions. Is this not the precise fallacy here committed? If not what, pray, is consciousness but the criterion of subjectivity? To this selective synthetic activity the name of will is given, which could only be ignored if the scheme were really one of conscious automatism which it mysteriously is not. Alum in crystallizing, if endowed with reflective self-consciousness (as there seems to be nothing but the feebleness or simplicity of its molecular processes to prevent), would have a will and that will would be "free," that is, unhampered by external constraint. The reviewer is certainly striving here to keep close to his author, without straining for the incongruous which seems, nevertheless, dangerously near.

We might give up the attempt to follow the argument through the chapter on the evolution of consciousness as our inability to grasp the logic of the treatment of consciousness invalidates for us the whole. Convinced as the author is that all modes of energy have their conscious aspect it follows for him that these states are like states and that the highest may be evolved from the lowest concomitantly with the corresponding organisms. But it does not at all follow that because two stimuli are both vibrations of definite rates that the two corresponding sensations are like sensations, nor need it follow that because a certain rate and complexity of vibration takes place in a monkey brain and a similar but higher rate and complexity of motion occurs in the human brain the psychical processes of the two differ alone in degree. It certainly does not follow because consciousness is associated with neural processes that it is only a modification of some nonconscious process associated with some other neural process. In fact, if our criticism holds, the fabric of the argument dissolves and there remains an eminently readable and incidentally very instructive collection of facts and expositions. C. L. H.

The Brain in Relation with Psychic Phenomena.[1]

Some four years ago the editor of this Journal explained the tardy development in recent times of physiognomy and the allied sciences as a result of the baseless and extravagant claims of the phrenologists which tended to drive all serious investigators from the field of so much

---

[1]MINGAZZINI, GIOVANNI. Il Cervello in Relazione con i Fenomeni Psichici. Studio sulla Morfologia degli Emisferi Cerebrali dell'uomo. Con un'introduzione del Prof. Sergi e 43 figure. *Biblioteca Anthropologico-giuridico, Fratelli Bocca, Editori, Turin, 1895.*

charlatanism. The influence of the Italian school of criminal anthropology which was at that time permeating Europe has since made a profound impression in this country, and indeed the avidity with which the public has siezed upon the wildest vagaries of the most reckless apostles of degeneracy offers in itself a profitable study for the neurologist. And so again the more conservative scientists are inclined to look upon all that is associated with the new criminology with suspicion and a truly impartial view becomes difficult.

It is the more gratifying therefore to note the appearance of this work of Dr. Mingazzini, a work fully in sympathy with all the positive results of the school of Lombroso and yet preserving throughout that judicial attitude whose assurance rests on the secure foundation of carefully complied and well digested statistics. The work is by no means a popular treatise, but is well adapted to put the actual facts of the subjects discussed before the busy reader who is supposed to possess already some knowledge of the matter. We are therefore introduced at once to the technical description of the variant features of the human brain in its different social and ethnic aspects.

First, fifty pages are devoted to the Morphology of the Cerebral Hemispheres of the Human Fetus and of the Primates. This discussion is very thorough, summarizing not only the observations of previous investigators but also the elaborate studies of the author himself. These latter consist largely in the details of numerous measurements of the brains of primates and men and constitute a very valuable addition to the literature. The resemblance anticipated on *a priori* grounds between the brains of man and the primates is not wanting provided we compare not adult primates with embryonic men, but, following the course approved by all modern research, comparing the human fetus with embryonic stages of the various primates. The author is inclined to agree with Vogt that "of the higher anthropoids no one can be said to be nearer than another to man" and with Gratiolet that the American simians have deviated less from the common ancestor of men and apes than have the anthropoids.

The remaining chapters take up successively the following topics: The Morphology of the Cerebral Hemispheres in the Sexes, in the Human Race, in Persons of Genius and High Intelligence, in the Case of Deformed Crania, in Criminals, in the Insane and Deaf-Mute, and in Microcephalia. The final chapter reviews the chief views concerning microcephalia and discusses the interpretation of degenerative stigmata. If, after the perusal of these chapters, the reader is somewhat disappointed at the meagerness of the positive results, it is because the au-

thor has been able to present both sides of each issue fairly and openly and the simple statement of all the facts is often sufficient to throw doubt upon many cherished popular ideas. The discussion of the real significance of the relation of the frontal lobes to high intelligence is a case in point. The general effect however of these chapters is not to discourage research, but by pointing out that the real weakness of all previous work has been generalization on too slender a foundation of observed fact to encourage more active and thorough research along all of these lines.

The question of degeneracy is introduced by an elaborate critique upon microcephalia, a character which from its historical and other importance occupies a crucial position in the whole discussion. The atavistic and pathological theories of the origin of microcephalia are both rejected, or rather, they are harmonized in a single new theory. The argument is somewhat as follows. Ontogeny being a compressed recapitulation of the phylogeny, many terms of the latter being suppressed in the former, we may assume that terms not expressed are latent. These latent terms require only a favorable disposition of the organism to become patent and to remain permanently in the organism. Such a disposition may be furnished by disease, etc. It is then impossible to establish a fixed barrier between atavism and pathology, and the search for a type of microcephalic brain is obviously useless. The anomalies which may return at any time are so numerous and depend for their presence upon so many complicated conditions that they will never be repeated. An atavistic vestige then is nothing else than *a sign indicating that the evolution of an organ has not been accomplished with complete and normal regularity ; the disease is the necessary condition for the revival of the atavism.*

This granted, the conclusion follows : a phylogenetic record upon the surface of the cerebral mantle has no other value than that appearing on any other organ, and consequently to judge of the abnormality of an organism the presence of atavistic characters in other organs should be taken into account. Now we understand why the number of degenerative stigmata seems to increase in the insane, epileptic, idiotic, and criminal and why with the number of stigmata the number of diseases should naturally increase.

Again, the author says, in the word "abnormality" or in the more usual term "degeneration" it is impossible therefore to find anything definable, but we affirm that an individual has departed from the normal, that is from the normal state of the species to which he belongs, in proportion to the traces either of the advance of morbid processes or of

anomalies which may be either atavistic or simply indicative of an arrest of development, or in other words, the more numerous are the signs of degeneration.

Mingazzini, then, arrives by this more direct route at the same conclusion as Feré in his recent work on the Neuropathic Family, that while degenerative stigmata exist and are of great value to the neurologist and the criminologist, yet it is and will forever remain impossible to define a "criminal type" as a fixed morphological entity.

Not the least valuable part of the work is the bibliography appended to each of the chapters. These are full, though by no means complete, the American literature having been most neglected. Such a book is of the greatest value, not merely, perhaps not chiefly, for the new facts which it contains, though these are by no means inconsiderable, but for the illumination which it throws over the entire field, revealing the points both of strength and of weakness and pointing the way for coming investigators.

C. J. H.

Catalepsy.[1]

This study is confined to catalepsy as observed in mental disease. The author considers that here it has only the value of a symptom and that it may develop in almost all mental diseases. The cataleptic states which appear in the course of the psychoses are characterized by the slowness of their invasion and termination and by their duration. Their progress is more often remittent than intermittent. They are usually incomplete, partial. They coexist with an augmentation of the muscular tension and an enfeeblement of voluntary psycho-motor activity. They appear to be due in general to disturbances of perception which abolish the sensation of fatigue or render it confused and which determine the persistence of the motor images transmitted, with their corresponding excitations. In the great majority of cases hysteria takes no part in the production of the cataleptic states observed in mental diseases. When it coexists with a psychosis it may produce in the course of the latter catalepsy of the hysterical type. Cataleptic phenomena may be simulated by the insane who are dominated by a delerious idea or an hallucination; by individuals who are not insane who wish to exempt themselves from some social burden. In these cases the myographic curve and the curves of the pulse and the respiration can unveil the deception. C. J. H.

[1] LE MAITRE, PAUL. Contribution à l'étude des Etats Cataleptiques dans les Maladies Mentales. *Paris*, *G. Steinheil*, 1895, pp. 96, 2 plates.

Dual Brain Action.[1]

The case presented is of unusual interest in the fact that well marked physical conditions are seen to coincide with the two mental states. The patient, a sailor and a Welshman, was a noisy, destructive dement. He exhibited frequent alternations of condition, in one of which he used his right hand by preference and spoke and understood English and was talkative, crafty and destructive. In the second, or Welsh, condition he is left handed and apathetic, speaks Welsh and that very imperfectly and scarcely distinguished one object from another. In this case either hemisphere seems to be capable of independent action, the change from one to the other being the occasion of the change from Welsh to English and from left to right handedness. The pulse curves in the two conditions are very unlike so that a change in circulation may be suggested as as an occasion for the transition. It may be noticed also that an intermediate condition in which the patient is ambidextral and used either language also occurs. It is suggested that only the left hemisphere has been educated and that this, rather than the unequal ravages of disease, accounts for the patient's greater proficiency in the English stage.

C. L. H.

The Diseases of Personality.[2]

The first edition of this translation we have already noticed. In the present edition the translation has been revised and improved upon and some typographical errors have been corrected. In the second chapter we notice that the word "emotional" of the first edition has been replaced by the term "affective." The author's preface to the fourth edition is prefixed and the value of the work further increased by the addition of a full index.

The Cranial Nerves of Protopterus.[3]

This piece of work will interest comparative anatomists for reasons quite apart from the critical taxonomic position of the type studied. So exhaustive a study of any type and one based on so keen apprecia-

---

[1] Bruce, L. E. Notes on a Case of Dual Brain Action. *Brain*, LXIX, p. 54.

[2] Ribot, Th. The Diseases of Personality. Authorized Translation. Second, Revised Edition. *Chicago, The Open Court Publishing Co.*, 1895.

[3] Pinkus, F. Die Hirnnerven des Protopterus annectens. 7 plates and 10 text-figures. *Morp. Arbeiten Herausg. von G. Schwalbe*, IV, 2, 1895. Jena, G. Fischer.

tion of the morphological questions invoved could not fail to be of value no matter what the type under investigation.

In the study of the more minute ramifications gross dissections were supplemented by microscopic reconstructions in wax and by means of plats made on cross-section paper. The application of both these methods to the eye muscle nerves has yielded results whose accuracy and completeness contrast very favorably with the more crude results of the earlier investigators. These arrangements conform more closely to those of the lower Amphibia than to those of the bony fishes. The comparisons made with the Amphibia throughout are of the greatest interest.

Probably the most striking morphological feature brought out by these investigations is the discovery of a new cranial nerve in Protopterus which is not found in other vertebrates, a preliminary notice of which appeared in the Anatomischer Anzeiger last year. It arises near the median line in front of the optic nerve at the extreme cephalic end of the preoptic recess. It courses forward along the base of the brain near the median line, and upon emerging from the cranium takes its position at the ventro-mesal angle of the olfactory nerve. This it maintains up to the nasal membrane. It terminates in the skin of the upper border of the external nares. Like the olfactory nerve it is nonmedullated. It has nothing to do with the recessus neuroporicus [lobus olfactorius impar] as it lies at the ventral end of the lamina terminalis. Dr. Pinkus very wisely declines to discuss its morphology until there is a better observational basis. No safe conclusions can be drawn until more is known of its inner course and connections.

In the discussion of the trigeminus and facial systems many valuable points are brought out. The morphological conclusions are based upon and in the main agree with those expressed by Strong in his earlier papers. In the Amphibia two types must be distinguished, the aquatic and the terrestrial, as indicated in the following table.

Type I.

Urodele larvæ, Perennibranchiata, Derotrema, and Aquatic Salamanders.

The Trigeminus posseses

1. R. maxillaris, which subdivides into
    a) r. maxillæ inferioris,
    b) r. maxillæ superioris,
2. R. ophthalmicus profundus.

The Facial consists of

1. R. hyoideomandibularis,
2. R. lateralis, which subdivides into
    a) R. ophthalmicus superficalis facialis,

b) R. buccalis,
c) R. mandibularis externus to the hyoideomandibularis.
3. R. palatinus.

Type II.

Land Salamanders.

The Trigeminus consists of

1. R. maxillæ inferioris,
2. R. maxillæ superioris,
3. R. ophthalmicus [profundus].

The Facial consists of

1. R. hyoideomandibularis,
2. R. palatinus.

In type I the divisions of the R. lateralis facialis supply the supraorbital, infraorbital, and mandibular lateral canals respectively. In the various species of Amphibia this ramus is developed inversely as the ramus maxillæ superioris; it disappears in the terrestrial forms with the atrophy of the lateral canals. Type I is illustrated by larvæ of Salamandra maculata, Type II by Geotriton [Spelerpes] fuscus. Amblystoma punctatum obviously lies between these extremes. Protopterus conforms in general to Type I.

C. J. H.

Huber's Histology.[1]

This little book comprises a series of practicums, apparently those used by the author in his classes, though the copy furnished us lacks both title page and imprint. It is adapted for classes in medical schools and elsewhere where it is desired to furnish the class with material already prepared for the demonstration of structure rather than to give instruction in the technique of the laboratory. Provision for the latter is made, however, by the addition of a section of about 50 pages on the methods for laboratory work. This section includes methods for macerating, hardening and fixing, decalcifying, impregnation, injecting, embedding, staining, and methods for preparing and staining blood preparations. The last is accompanied by an excellent plate of blood elements. The selection of methods has in the main been judicious, though our experience would hardly justify so free use of mercuric chloride as a fixer. The expositions are both clear and concise. In the body of the book the number of exercises given under each topic is small, but here again good judgment has been shown in their selection. Thus 19 studies are devoted to the nervous system, 7 to periph-

[1]For sale by George Wahr, Bookseller and Stationer, Ann Arbor, Mich. $1.50.

eral nerves, 7 to nerve cells, and 5 to spinal cord, cerebellum and cerebrum. Mechanically the book is badly constructed. The binding of blank pages of ordinary book paper into a laboratory guide for the student's drawings is a practice not to be recommended. It is our experience that much better results are secured by the use of tablets of good drawing paper properly punched so that they can at the end of the course be bound up in any desired order by the student. Even if the guide is interleaved with good drawing paper, this arrangement is inconvenient and otherwise objectionable.

C. J. H.

The Eyes of Decapods. [1]

Investigations on the invertebrate nervous system have of late scarcely kept pace with the phenomenal advances made in the domain of the vertebrates. This of course is largely due to the enormous difficulties encountered in the development of an appropriate histological technique. It is therefore with considerable interest that we watch the result of each new attempt to apply to the various tissues of the invertebrates the modern methods which have made possible the great discoveries of the last decade in vertebrate neurology. This monograph by Dr. Parker brings into prominence very vividly the great fruitfulness of this field when it is cultivated by one who has the patience and ingenuity necessary to overcome the mechanical difficulties of the research. In these days when the literature is made up so largely of the immature productions of callow students and of preliminary notices of observations which are never verified it is a grateful relief to meet with a study so thoroughly and symmetrically executed as this one.

It is impossible to give an adequate abstract of the paper without reference to the accompanying plates; a few only of the author's conclusions are therefore presented. The methods which yielded the most valuable new data were those of Golgi and Ehrlich (methylen blue). A valuable feature is the systematic counting of all the elements of the eye and ganglion which could be made available for the purpose. The fibres of the rhabdome are regarded as nervous structures, the distal ends of the fibrillæ of the retinal nerve fibres. Each retinula is made up of seven elements, each of which represents a single cell which is a neuron in the sense of Waldeyer. The details of the structure of the rhabdome are presented with great distinctness. The pigment was

[1] PARKER, G. H. The Retina and Optic Ganglia in Decapods, especially in Astacus. *Mittheilungen a. d. zoologischen Station zu Neapel*, XII, 1, 1895.

carefully studied and its physiological significance worked out. The theory of vision adopted is that of Max Schultze and Grenacher, that the rhabdome is the perceptive organ of the retina. The experiments to determine the character of the image thrown upon the retina seem to have been more carefully planned than those of the previous observers and are regarded as important in two respects. "They show that, when the rhabdome is surrounded by pigment, its whole length can be penetrated only by very strong light, though its distal end can always be illuminated even by diffused daylight, and, secondly, they confirmed the belief entertained by Müller, Grenacher and Exner that the image in the compound eye is a single upright one for the whole retina, whose perceptive elements, the rhabdomes, receive each a single impression." The optic ganglia, their decussations, and the optic nerve receive full treatment. C. J. H.

The Ciliary Ganglion.[1]

Schwalbe, from comparative and embryological studies, came to the conclusion that the ciliary ganglion is a root ganglion for the oculomotorius. The recent discovery that the cells of the cerebro-spinal ganglia, except the acustic, are always unipolar with a single dichotomous axis-cylinder, while the cells of the sympathic ganglia are multipolar, both in man and other mammals, has afforded an opportunity to test decisively whether the ciliary ganglion is to be placed in the former or latter category. In accordance with this principle, the author has previously shown that the following cranial ganglia belong to the cerebro-spinal system,— *g. jugulare*, *g. cervicale n. vagi*, *g. petrosum n. glossopharyngei*, *g. geniculi n. facialis*, *g. seminulare n. trigemini;* while the following ganglia must be relegated to the sympathic system,— *g. oticum*, *g. sphenopalatinum*, *g. submaxillare*, *g. ciliare*. The ciliary ganglion was studied anew in the light of Schwalbe's results to determine whether it might not be a mixed ganglion, but the result was only a confirmation of the first conclusion. The application of the Golgi method to the ganglion in the hands of Van Gehuchten gave negative results and that author is inclined to regard it as a cerebro-spinal ganglion. Retzius has finally succeeded in securing adequate impregnations and finds that his first result is fully confirmed again. The cells are all of the multipolar sympathic type and there are no unipolar cells among them. It appears that Michel has independently secured the same results by the same method.

[1] RETZIUS, GUSTAF. Ganglion Ciliare. *Biol. Unters.*, N. F., VI, 2-3, 1894.

The Physician's Visiting List.

Lindsay and Blakiston's Physician's Visiting List for 1896 has been placed on our table. This old favorite needs no introduction to the profession from us. We will merely call attention to the improvements contained in the forty-fifth issue.

More space has been allowed for writing the names and to the "Memoranda Page;" a column has been added for the "Amount" of the weekly visits and a column for the "Ledger Page."

To do this without increasing the bulk or price, the reading matter and memoranda pages have been rearranged and simplified.

The Lists for 75 Patients and 100 Patients will also have special memoranda page as above, and hereafter will come in two volumes only, dated January to June, and July to December. While this makes a book better suited to the pocket, the chief advantage is that it does away with the risk of loosing the accounts of a whole year should the book be mislaid.

The Annual of the Universal Medical Sciences.[1]

We cannot too highly commend to the medical profession this annual review of the periodical literature. Of course, every physician reads his medical journals; but no physician can read all of the journals, not even those of his own specialty. This is done for him by the editors of the Annual and the results classified and presented in a very accessible form. Altogether the work stands without a peer. The issue of 1895 is at hand and presents the usual wealth of quotation and illustration.

Brain Origin.

Sir William Broadbent's Presidential Address before the Neurological Society of London last January[2] deals with several interesting theoretical matters under the title given above. A good point is made bearing on the relation between the peripheral and the central nervous organs. "All who have attempted to grasp the mystery of nervous action have recognized that the nerve endings are highly specialized and endowed with some powers allied to those of the centres. This is

[1]Edited by Charles E. Sajous, M.D., and seventy associate editors, assisted by over two hundred corresponding editors, collaborators, and correspondents. Five volumes, illustrated by chromo-lithographs, engravings and maps. *Philadelphia, Pa., The F. A. Davis Company.*

[2]*Brain*, Parts II and III, 1895.

especially evident in the case of the sensory nerves and attains its highest development in the retina and auditory nerve. . . . There can be no difficulty, then, in supposing that at the sensory terminal distribution generally, force is continuously generated and maintained at a certain degree of tension, which is balanced and resisted in the nerve centres by force there generated. In the same way the relation between the motor nerve endings and the motor nerve nuclei in the cord would be one of balanced tension. The muscular tonus which gives rise to the knee jerk would appear to be the peripheral expression of such a relation." This relation of mutual tension and reciprocal control finds its expression in a great variety of very familiar activities and inhibitions, including trophic influence. In the latter case, "the nerve endings in skin and muscles are identified in their nutrition with the structures to which they are distributed. The muscles, indeed, may almost be looked upon as end-organs of the motor nerves. Through this community of structure and nutrition with the nerve terminations it seems to me that the tissues will take part in the maintenance of the tension between periphery and centres, while in turn the nerves will influence the nutritional processes in the tissues just as by way of analogy, heat and electricity condition chemical action."

C. J. H.

The Central Connections and Relations of the Trigeminal, Vago-Glosso-pharyngeal, Vago-Accessory and Hypoglossal Nerves.

Under the above title Dr. Wm. A. Turner presents some interesting results in the *Journal of Anatomy and Physiology* for October, 1894, based upon a study of silver preparations of newly-born kittens, Weigert-Pal preparations of an eight-months' human foetus, experimental work on monkeys and cases of bulbar paralysis. We offer his summary:

1. The hypoglossal nucleus is solely a nucleus of origin; the *efferent* fibres are the axis-cylinder processes of the cells of the nucleus of the corresponding side, and have no direct connection with opposite nucleus, or with the nuclei of Roller and Duval; the *afferent* hypoglossal fibres are derived from the pyramids, forming in chief part the *fibræ propriæ,* also from the reticular formation, and possibly from the fillet.

2. The *nucleus ambiguus* is the nucleus of origin of the motor fibres contained in the roots of the glosso-pharyngeal, vagus, and vago-accessory nerves, and innervates, among other structures, the levator palati and internal thyro-arytenoid muscles. The *afferent* fibres of the glosso-pharyngeal and vagus roots are the axis-cylinder processes of the

ganglia upon these nerves, which terminate in the posterior vago-glossopharyngeal nucleus and in the gelatinous substance around the *fasciculus solitarius* (Kölliker). These facts are confirmed by observation of cases of bulbar paralysis, and by experimental section of the glossopharyngeal root. These structures therefore form the nuclei of termination of the combined vago-glossopharyngeal nerve.

3. The *substantia gelatinosa* and *spongiosa*, situated in the lateral parts of the medulla oblongata and pons Varolii, forms the end-nucleus of the so-called ascending trigeminal root, the fibres of which are the axis-cylinder processes of the cells of the Gasserian ganglion (Kölliker). Section of the sensory division of this nerve is followed by degeneration of the ascending root through the gelatinous substance into the *substantia spongiosa*, where the fibres break up into end-tufts. In this situation are cells, chiefly of Golgi's first type, whose axis-cylinder processes pass into the reticular formation.

4. The motor nucleus of the fifth nerve is the nucleus of origin of most of the fibres of the motor root, the fibres being the axis-cylinder processes of the large multipolar cells of the nucleus.

5. The so-called descending trigeminal root is composed of the axis-cylinder processes of the cells in the outer part of the Sylvian grey matter, and joins the motor division of this nerve. It is not improbable that this nucleus innervates some of the muscles supplied by the fifth cranial nerve. It is not "trophic" in the sense used by Merkel.

6. There is no direct cerebellar root of the fifth nerve. What has previously been described as such is a tract of fibres passing between the roof nuclei and the nucleus of Deiters, and probably also between the superior olivary bodies and the roof nuclei of the cerebellum (Bruce).

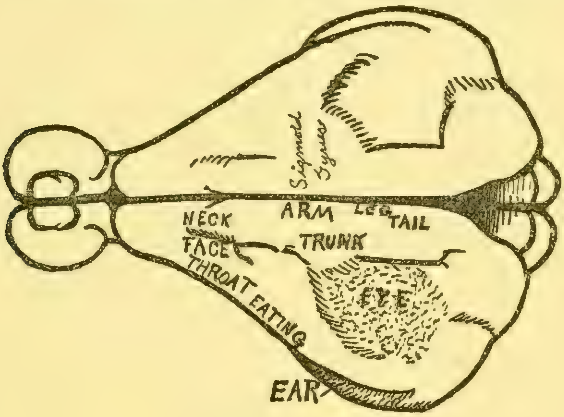
Homoplasty of the Brain.[1]

The attempt to establish homologies on the basis of external characters alone is rapidly being abandoned in most departments of neurological research. The extremes of error to which this method may lead are well illustrated by the homologies current until recently for the various parts of the fish brain. It would seem as if the other extreme, that of painstaking experimental localization of homologous functions, were represented in the paper under consideration. The new experiments were performed on hedgehogs (*Erinaceus*), cats and rabbits. The comparison of the cortical areas of the cat and the dog

[1] MANN, GUSTAV. On the Homoplasty of the Brain of Rodents, Insectivores, and Carnivores. *Jour. Anat. and Physiol.*, N. S., X, 1, Oct., 1895.

develops a number of interesting points correlated with the habits and instincts of these animals. Compare the results of Polimanti on the functional distribution of the motor roots from the cord of these animals.[1]

The cerebrum of the hedgehog—hitherto described as smooth—is found to present a very rudimentary Sylvian fissure and another more strongly developed which the experiments permit to be homologized without doubt with the pre-sylvian fissure. He adds, "On comparing the brain of the hedgehog with that of the dog and monkey, it will be



The Brain of the Rabbit.

seen that the conclusion arrived at by Sir William Turner, namely, 'that the pre-sylvian and pre-central fissures are homologous'—a conclusion based on Ferrier's researches—is fully born out."

The experiments on the rabbit's brain were very complete and amply verified. The results are presented in the accompanying diagram copied from the author's. It is to be noted that the areas for the eye and ear are centres of motion, not of sensation. The discovery of a sigmoid gyrus and the perfectly typical arrangement of the motor areas as compared with the other mammals are points of the greatest interest. C. J. H.

Memory and the Specific Energies of the Nervous System.[2]

The two lectures bound up in this little volume are both suggestive. The first will prove of especial interest in connection with the

---

[1] *Lo Sperimentale*, XLVIII, 3, 1894.

[2] HERING, EWALD. Memory as a general Function of Organized Matter and The Specific Energies of the Nervous System. *Chicago, The Open Court Publishing Co., 1895.*

problem of so-called unconscious cerebration. Some familiar facts are set forth in a new light. The application of organic memory to heredity, while not new, is aptly put.

The second article is an enthusiastic plea for Johannes Müller's theory of specific energies of nerves and an attempt to apply it more widely to the rest of the nervous system and indeed to the body as a whole. This doctrine has been in the main supplanted by that of central analysis and control and its revival is another indication of the growing tendency among biologists to emphasize the importance of the periphal activities of the body as contrasted with the older idea of a dominant central control of all bodily faculties.

But the reviewer fails to understand why the doctrine, if accepted at all, should be confined to the peripheral parts of the nervous system. At birth each of the sensory nerves is accredited with a specific energy, but the higher centres of the brain are spoken of as "virgin." By a process of education each element of these parts of the brain acquires "an increased ability to reproduce the same kind of irritation by a permanent change of its internal structure" until finally the cerebral cells all acquire specific energies. Is not this a far worse extreme than the one controverted? For why deny to the cerebrum those hereditary predispositions which are so freely granted to the peripheral nerves, and this too in the face of all which we know of cephalization and the allied principles? If we may be permitted to apply the doctrine of inherited specific energies to the whole nervous system and *particularly* to the central nervous system, it becomes a useful principle.

Perhaps the most valuable point made in the essay is on the question of method. Speaking of the difficulty of demonstrating the physical basis of specific energies, he says, "To reveal the delicate secret of living matter by the comparatively crude methods of chemistry, would be like trying to explain the mechanism of a watch by melting it in a crucible, and examining the molten mass with respect to its ingredients."

C. J. H.

The Illinois Society for Child Study.[1]

It has become quite the fashion in some quarters to ridicule every attempt at popularizing the study of child-psychology and more especially the introduction of the study of these problems into the home. It cannot be gainsaid that the results of such study are in many cases highly ridiculous; and yet the most unscientific observer, even though she be

[1] Transactions of the Illinois Society for Child Study. Vol. I, Nos. 1 and 2. *Chicago, Ill., The Werner Co.*, Dec., 1894 and May, 1895.

at the same time a mother, cannot carry out a system of observations on young children *under proper direction* without deriving much of edutional value from it. True, the scientific results of such amateurish study will be slight; yet aside from this, the societies for child study find ample justification as educators of parents and primary teachers. It would seem as if no one could observe the hap-hazard way in which children are usually allowed to grow up in the home and the hopelessly mechanical treatment which they too often receive during the first years at school without being impressed with the importance of a more thorough pedagogical training on the part of those upon whom devolves the moulding of the child's mind during its most formative period. Of course there is the danger that inexperienced hands may bungle and develop self-consciousness instead of self-possession on the part of the child. And here much depends on the direction given.

The Illinois Society for Child Study would seem to be especially favored in its leadership. The presence on its executive committee of such men as Drs. W. O. Krohn, H. H. Donaldson, A. Meyer, and Bayard Holmes, carries with it the assurance of high scientific ideals and a very practical application of them. The papers thus far issued in the official organ of the society are of a very miscellaneous character and of very unequal practical importance. They are all suggestive and well adapted to their double purpose of education and permanent scientific record. Probably the most important single paper is Dr. Krohn's translation, in the first number, of Preyer's "Directions for Conducting a Daybook Recording the Development of the Infant from Birth."

C. J. H.

Princeton Contributions to Psychology.[1]

These semi-annual publications evidence a very commendable activity on the part of the Princeton psychologists. The studies in the present fasciculus may be characterized as practical and suggestive

---

[1] Edited by J. MARK BALDWIN. Vol. I, No. 2. Reprinted from *The Psychological Review.* Princeton, N. J., The University Press, Price 50 cents.

CONTENTS.

rather than profound. Those dealing with square-size have an obvious application to decorative art which is of considerable importance. Professor Baldwin's paper on Types of Reactions deals with the question of "sensory" and "motor" reactions. He cites two cases in which the "motor" reaction is clearly longer than the "sensory," in one case fully ⅓ longer. He argues for the discrimination of sensory and motor types of reagents and claims that the custom of Wundt and his followers of excluding the motor reactions when they chance to be longer than the sensory is bad method. Professor Hibben gives the details of a case of partial or transitory deafness, in which the subject seemed totally deaf except in connection with objects of unusual interest, a very instructive illustration of normal functioning carried to abnormal excess. C. J. H.

The Ganglion Cells of the Spinal Cord.[1]

This essay received the prize of the American Neurologlcal Association. The results of the author's experiments on cats are detailed in the following summary.

1. The severance of the continuity of a spinal nerve or of both its roots is always followed by retrogressive changes both in cells which are intimately connected with its posterior roots and in cells from which its motor fibres originate.

2. a. These changes may set in gradually and consist in a gradual shrinkage of all parts of the cell accompanied by a modification of its structure, characterized by increased affinity to certain analine stains and evidently also by a solidification of its contents.

b. Or the changes may set in acutely, being marked by swelling and homogeneous transformation of the cell contents; this transformation begins in a circumscribed part of the cell-body and then spreading itself towards the periphery, it involves the processes and nucleus.

This transformation may lead to liquefaction and final absorption of the cell, or may arrest itself at a certain stage.

In specimens treated after Marchi's method, the beginning of the homogeneous transformation is marked by swelling and distinct differentiation of all parts of the cell, while normal cells receive a shrunken rudimentary appearance by this method, so that their ganglionic charac-

[1]B. ONUF [ONUFROWICZ]. The Biological and Morphological Constitution of Ganglionic Cells, as influenced by Section of the Spinal Nerve Roots or Spinal Nerves. To which is appended some remarks on localization. *Journal of Nervous and Mental Disease.* XX, 10, Oct., 1895.

ter can hardly be recognized. In later stages of the degeneration the differentiation of the various parts becomes lost.

3. The character of the retrogressive changes is determined.

a. By the distance of the point of lesion from the cell.

b. By the character of the cell, or more probably by the manner of its connection with the severed fibres.

In "motor" cells severance of the motor fibre near origin from the cell (section of the anterior root) is followed by the acute changes, viz. by homogeneous transformation of the cell.

Lesion of the motor fibre at a considerable distance from the cell effects as a rule the gradual changes, that is, a gradual shrinkage of the cell; but occasionally, as the case of amputation reported by Kahler and Pick proves, also here the changes in the "motor" cells may have the character of homogeneous degeneration.

In the cells of Clarke's columns, in the small cells situated at the base of the posterior horns, and in those of the lateral horns the changes always bore the character of the gradual shrinkage, no matter whether the nerve (larger distance), or the roots (small distance) was severed. Here the manner of the connection between the severed fibre and the cell which undergoes the change is less intimate than the connection between "motor" cell and motor fibre, as the latter is the principal part of the neuron of which the "motor" cell forms the centre.

4. The gradual shrinkage gives probably much more chance for recovery of the cell, if the continuity of the severed nerve fibre can be restored, than the homogeneous degeneration.

5. The small cells situated at the base of the posterior horns along the course of the nerve bundles, which pass from the ventral part of the posterior columns towards the lateral columns, are intimately connected with the posterior roots. Part of these cells are connected with posterior root fibres of the same side, part with posterior root fibres of the opposite side. This connection probably consists in close contact of the terminal branches of the posterior root fibre with the network into which the axis cylinder of the altered cell dissolves itself; nothing positive can be stated in that regard, however, without examination by Golgi's or Ramon y Cajal's method. The latter makes no mention of said cells.

6. The cell group of Clarke's columns is in connection with fibres of the posterior roots both of the same and opposite side.

7. Of the cells of the medial zone (Waldeyer's "Mittelzellen"), and of the small cells of the lateral horn, I can only state, that they

undergo a shrinkage after the severance of the peripheric nerve or its roots, but cannot decide with which of the roots they are connected.

8. The group of cells which supplies the muscles of the back with motor fibres, occupies the medial and anterior horn, which is in accordance with the views of Kaiser and Collins respecting the function of this group.

In conclusion I wish to recommend warmly Nissl's method of staining as a valuable addition to the methods in use for the investigation of the central nervous system. For the study of the finer structure of ganglionic cells it is much superior to the nigrosine, carmine and similar stains. This superiority is due to the fact stated by Nissl, that the hardening with the chromsalts damages the structure of the cells, for which reason fine cell changes will easily escape observation.

Degenerations of Sensory Tracts in the Spinal Cord.[1]

Dogs were experimented upon by cutting the dorsal roots of one side, in one case of the lumbro-sacral plexus, in another case of the four last dorsal nerves. In the former case the dog was kept alive 33 days, in the latter two months and a half. The spinal cord was treated by a modification of Marchi's method.

1. In the portion of the cord corresponding to the six sensory roots cut from the lumbro-sacral plexus the degeneration is conspicuous in both the white and the gray matter. In the former it extends also to the dorsal columns of both sides, to the direct cerebellar tracts of both sides, to the white and gray ventral commissure, a few to the ventral columns, and a still smaller number to the intra-medullary fibres of the ventral roots. In the grey matter degeneration is noted in the entering fibres of the dorsal root, in the transverse section of the longitudinal fibres and of the fibres running between the base of the dorsal cornu and the centre of the grey matter, and in the nerve cells, not a few of which are atrophied, some granulated and some disappeared.

2. In adjacent regions cephalad the degenerative process is always conspicuous in the dorsal columns, limited, however, to the internal portion of the columns of Burdach and Goll. It is equally conspicuous in the direct cerebellar tracts, especially in the dorsal part. Few degenerate fibres are seen in the ventral columns, and they are rare in the ventral commissure. It is never observed in the intra-medulary fibres of the dorsal or of the ventral root. In the grey matter

[1] PALADINO, G. Gli effetti della recisione delle radici sensitive del midollo spinale e la loro interpretazione. *Annali di Nevrologia*, XIII, 1-2, 1895.

traces of degeneration always appear in the fibres at the base of the dorsal cornua.

3. In more distant regions cephalad the degeneration is limited apparently to the column of Goll, though the possibility of its affecting the innermost fibres of the column of Burdach is not excluded. In the lateral columns it is limited to the dorsal part.

4. Comparing these degenerations with those which appear in points caudad of the injured area, the differences are notable. If the alterations are bilateral, there is much difference between the two sides. The degenerations are distributed very differently from those described by other observers and from those just described. Adjacent to the injured area they are limited to the most external part of the column of Burdach, with an enormous difference between the two sides. Much less extensive is the degeneration of the lateral columns, also with conspicuous difference between the two sides. The degeneration of the most internal part of the ventral columns is very noticeable with little or no difference between the two sides; there is, moreover, a certain amount of degeneration in the ventral commissure. In more distant regions caudad the degenerate fibres diminish conspicuously and apparently none are present in the dorsal columns.

5. In the case of the second dog, from which the sensory roots were cut in the four last dorsal segments, the results were essentially the same, with, however, the difference that in the descending degeneration the cells of the grey matter are affected in a significant manner. They are atrophied, granulose and with a remnant of the neurological reticulum on the surface.

The paper concludes with a discussion of the physiological and trophic significance of the facts presented.

C. J. H.

Post-Darwinian Questions.[1]

"Some time before his death Mr. Romanes decided to publish those sections of his work which deal with Heredity and Utility, as a separate volume, leaving Isolation and Physiological Selection for a third and concluding part of *Darwin, and after Darwin.*"

The preceding paragraph from Professor Morgan's introductory note sufficiently explains the scope of the present volume. We are

---

[1] ROMANES, GEORGE JOHN. Darwin and after Darwin: an Exposition of the Darwinian Theory and a Discussion of Post-Darwinian Questions. II. Post-Darwinian Questions, Heredity and Utility. *Chicago: The Open Court Publishing Company*, 1895.

further told that most of the matter contained in this part was already in type, though not finally corrected for the press, at the time of the author's untimely death. These, as well as the other parts which were left in manscript, have suffered only verbal alterations at the hand of the editor.

The work falls into the two great sections indicated in the sub-title, the first chapter constituting a general introduction to the whole. As this introduction has been otherwise published in a leading periodical we need not stop to review it here.

The first section on heredity, which receives the title, Characters as Hereditary and Acquired, is taken up almost wholly with the speculations of Weismann; it, however, covers very different ground from the earlier work, "An Examination of Weismannism." The logical system which goes by the name of Weismannism is graphically described as consisting of a basal postulate as to the absolute non-inheritance of acquired characters, upon which is erected a Y-like system of deductions. The stem of the Y is the deduction as to the absolute continuity of germ-plasm, the limbs of the Y are constituted by deductions as to the architecture of the germ-plasm and deductions as to the theory of organic evolution respectively. Now, in the *Examination* Mr. Romanes assumed the postulate and then examined the deductions which make up the Y; in the present work he deals only with the basal postulate.

But here we meet a dead-lock which Mr. Romanes has taken great pains to make plain both in this connection and in previous publications. Weismann calls for proof that acquired characters are not transmitted in a state of nature. But when an apparent case of such transmission is presented, he replies, How do you know that the characters in question are not adaptive and therefore perpetuated by natural selection? But if cases of the transmission of non-adaptive characters are adduced, he replies that there are no such characters. Seeing that natural selection is taken to be the only possible cause of change in species, it follows that all changes occurring in species must necessarily be adaptive, whether or not we are able to perceive the adaptations. The case, then, is very much like that of a doughty knight pitching his glove into the sea, and then defying any antagonist to take it up. "Probably enough has now been said," Mr. Romanes adds, "to show that the Neo-Darwinian assumption precludes the possibility of its own disproof from any of the facts of nature (as distinguished from domestication)—and this even supposing that the assumption be false. On the other hand, of course, it equally precludes the possibility of its own

proof; and therefore it is as idle in Darwinists to challange Weismann for proof of his negative (i. e. that acquired characters are not transmitted), as it is in Weismann to challange Darwinists for proof of the opposite negative (i. e. that all seeming cases of such transmission are not due to natural selection). This dead-lock arises from the fact that in nature it is beyond the power of the followers of Darwin to exclude the abstract possibility of Lamarckian principles. Therefore at present the question must remain for the most part a matter of opinion, based upon general reasoning as distinguished from special or crucial experiments. The evidence available on either side is presumptive, not demonstrative."

Mr. Romanes next proceeds to summarize the evidence, indirect, direct, and experimental, on both sides of the question. Under the caption of Indirect Evidences in Favor of Transmission, the most important section is that concerned with reflex action and instinct. As this evidence is new, it may be worth while to examine Mr. Romanes' argument at some length. "It belongs to the very nature of reflex action," he maintains, "that it cannot work unless all parts of the machinery concerned are already present, and already coordinated, in the same organism." It follows, of course, that the coordinated mechanism which thus constitues a physiological unit cannot have been developed by insensible gradations under the law of natural selection. The reflexes must, then, have originated as conscious acts which have been preserved and transmitted under Lamarckian principles; i. e. reflexes, like many instincts, are lapsed intelligence. The argument is presented under three heads. (1) The simplest piece of reflex machinery cannot have occurred—as a result of congenital variations alone—in any considerable number of individuals of a species *when it first began to be constructed;* if it should chance to occur it would be swamped by intercrossing. (2) Reflex actions, from their very nature, cannot admit of any very great differences in degree of adaptation; the working efficiency must be perfect from the start. (3) Even when reflex mechanisms have been fully formed, it is often beyond the power of sober credence to believe that they now are, or ever can have been, of selective value in the struggle for existence.

Now, it seems to me that the first two of these points lose all of their weight and the third much of its weight from a few very simple considerations. There is a theory of the origin of reflexes which is held by a not inconsiderable number of biologists which Mr. Romanes seems not to have taken into account. Going back to the most primitive properties of organized matter, we find prominent among these the

property of irritability. Simple protoplasm, then,—and much more, nervous protoplasm—has the property of returning a motor response to a sensory stimulus; this is mechanical, or, at least, it is not truly volitional. This motor discharge is the result of the chemical or biological instability of the protoplasm and at first will follow lines of least resistance. The strength of the reaction will depend, in a measure, at least, on the strength of the stimulus, and the reaction against all stimuli will at first be spasmodic, i. e. non-adaptive, just as the reaction against a too powerful stimulus is today in the highest animal. These primitive reactions, however, at once come under the influence of the law of natural selection and for normal intensities of stimulus the non-adaptive reactions will speedily be eliminated in accordance with known evolutionary principles. Of course, this view of the origin of reflexes (and of instincts, as well) has not yet been proven to the satisfaction of all; and yet, since it is held by a respectable number of biologists, it ought not to be neglected in a discussion of this sort.

Let us now examine in the light of this theory the illustrations brought forward by Mr. Romanes, which he states were chosen because they are fairly typical of the phenomena of reflex action in general. First, as to the reflex withdrawal of the foot upon an irritation, he says, "Even in its present fully formed condition it is fairly questionable whether it is of any adaptive *value* at all. The movement performed is no doubt an adaptive *movement*; but is there any occasion upon which the reflex mechanism concerned therein can ever have been of adaptive *use*? Until a man's legs have been paralyzed as to their voluntary motion, he will always promptly withdraw his feet from any injurious source of irritation by means of his conscious intelligence. True, the reflex mechanism secures an almost inappreciable saving in the time of the response to a stimulus, as compared with the time required for response by an act of will; but the difference is so exceedingly small, that we can hardly suppose the saving of it in this particular case to be a matter of any adaptive—much less selective—importance." Again, we are referred to the familiar complex of actions exhibited by the brainless frog. Of these actions those associated with the maintenance of equilibrium are selected for especial consideration.

Both of these cases are regarded as clear cases of lapsed intelligence and as quite inexplicable by any application of the theory of natural selection; but we have seen that this conclusion will not be universally accepted. Furthermore, in his first case, the slight saving of time by the reflex response as compared with the volitional response is by no means to be neglected. I should regard it as an adaptive char-

acter of the greatest selective importance; but of still greater imporance in this case, as well as in the second case, is the gain in the precision of the movement in the case of the reflex. Almost any oft-repeated reflex action can be performed not only more promptly but more perfectly without the aid of consciousness than with such interference. But a consideration of more importance than any of the preceding is the principle of mental economy. It is a familiar pedagogical maxim that education consists largely in the training of the lower centres so as to enable them to perform the mechanical duties of life unconsciously, thus leaving the mind free for the performance of higher duties. Mr. Romanes seems not to have recognized this when he says, "As long as the animal preserves its brain, it will likewise preserve its balance, by the exercise of its intelligent volition. And, if the brain were in some way destroyed, the animal would be unable to breed, or even to feed; so that natural selection can never have had any *opportunity*, so to speak, of developing this reflex mechanism in brainless frogs. On the other hand, as we have just seen, we cannot perceive how there can ever have been any *raison d'etre* for its development in normal frogs—even if its development were conceivably possible by means of this agency. But if practice makes perfect in the race, as it does in the individual, we can immediately perceive that the constant habit of correctly adjusting its balance may have gradually developed, in the batrachian organization, this non-necessary reflex." To this it need only be added that the reflex is normally present and is in constant use *as a reflex* in the uninjured body and that in this case, at least, it is by no means useless. The other illustrations adduced seem to me open to similar criticisms. Now, I do not mean to imply that no reflexes and no instincts are due to lapsed intelligence; but many reflexes and some instincts are certainly not so derived and Mr. Romanes' illustrations for the present discussion would seem to have been most unfortunately chosen.

Among the experimental evidences of the inheritance of acquired characters, the experiments of Brown-Sequard on guinea-pigs stand out as preeminent. They are, in fact, almost the only experiments which can be cited thus far which can be regarded as in any way decisive. The now famous experiments of Brown-Sequard are described and their results, so far as they are germain to the present discussion, are outlined, together with Weismann's comments upon them. But of far greater interest is the account of the long-desired verification of Brown-Sequard's experiments undertaken by Mr. Romanes himself. The first series of experiments was begun over twenty years ago and then yielded

negative results, hence were never published. Within the last decade they were resumed more systematically under the direction of Brown-Sequard himself. Brown-Sequard's conclusions as summarized by himself may be taken up in order.

1st. Appearance of epilepsy in animals born of parents which had been rendered epileptic by an injury to the spinal cord.

2nd. Appearance of epilepsy also in animals born of parents which had been rendered epileptic by section of the sciatic nerve.

These points have been previously verified by others, and the second was many times repeated by Mr. Romanes. The skin was removed from the anæsthetic area behind the ear, the irritation of which caused the fits, and it was found that no kind or degree of irritation supplied to the subjacent tissue had any effect in producing a fit.

3d. A change in the shape of the ear in animals born of parents in which such a change was the effect of a division of the cervical sympathetic nerve.

4th. Partial closure of the eyelids in animals born of parents in which that state of the eyelids had been caused either by section of the cervical sympathetic nerve, or by the removal of the superior cervical ganglion.

The author performed few experiments and these with negative results.

5th. Exophthalmia in animals born of parents in which an injury to the restiform body had produced that protrusion of the eyeball. . . . In these animals, modified by heredity, the two eyes generally protruded.

Brown-Sequard's results were in the main verified here, though the author is not willing to base any final conclusions upon his experiments.

6th. Haematoma and dry gangrene of the ears in animals born of parents in which these ear-alterations had been caused by an injury to the restiform body.

These results were corroborated. In the progeny the morbid process never goes so far as in the parents which have been operated upon, and it almost always affects the *middle* thirds of the ears. Two photographs illustrate this point. "It should be observed that not only is a different *part* of the ear affected in the progeny, but also a very much less *quantity* thereof. Naturally, therefore the hypothesis of heredity seems less probable than that of mere coincidence on the one hand, or of transmitted microbes on the other. But I hope to have fairly excluded both these alternative explanations. For, as regards merely accidental coincidence, I have never seen this very peculiar morbid process in the ears, or in any other parts, of guinea-pigs which have neither themselves had their restiform bodies injured, nor been born of parents thus mutilated. As regards the hypothesis of microbes, I have tried to inoculate the corresponding parts of the ears of normal guinea-

pigs, by first scarifying those parts and then rubbing them with the diseased surfaces of the ears of mutilated guinea-pigs; but have not been able in this way to communicate the disease."

7th. Absence of two toes out of the three of the hind leg, and sometimes of the three, in animals whose parents had eaten up their hind-leg toes which had become anæsthetic from a section of the sciatic nerve. . .

The author's experiments in this connection were carried on through a series of six successive generations, so as to produce, if possible, a cumulative effect. Yet no effect of any kind was produced.

Not less interesting is the vast series of experiments undertaken by the author which yielded only negative results. These included thousands of experiments on graft-hybridization both of plants and of animals,—bulbs, buds, tubers, the combs of Spanish cocks on the heads of Hamburgs, in mice and rats the grafting together of different varieties, and in rabbits and bitches the transplantation of ovaries of newly born individuals belonging to different breeds. The author was, however, never able to obtain a graft in the latter case. The experiments carried out in the transfusion of blood and the transplantation of fertilized ova between different varieties of rabbits prove to have been utterly irrelevant, for it appears that rabbits, even when crossed in the ordinary way, never throw intermediate characters. Mr. Romanes therefore promptly on this discovery made arrangements for again repeating the experiments—only, instead of rabbits, using well-marked varieties of dogs. But the completion of this research was denied him by failing health.

Much of the matter contained in part I. would be in the hands of another a mere fruitless threshing over of old straw, but by reason of his extensive experimental work every opinion expressed by Mr. Romanes is weighty. His death just at this time is therefore the greater loss.

Section II, on Utility, is devoted to an elaborate, and as it seems to me, a final proof of the inadequacy of natural selection as a universal cause of evolution. Into the details of this discussion we can not here enter. C. J. H.

Influence of Sensory Nerves upon Movement and Nutrition.[1]

Upon section of the whole series of sensory roots belonging to a limb, the movements of the hand and foot are practically abolished,

[1] MOTT, F. W. and SHERRINGTON, C. S. Experiments upon the Influence of Sensory Nerves upon Movement and Nutrition of the Limbs. Prelim. Communication. *Proc. Roy. Soc.*, LVII, 345, 24 May, 1895.

and that permanently. In the animals experimented upon—monkeys—the movement of grasping never occurs either with hand or foot. The affected limb hangs passively flexed. Associated movements of the limb are comparatively little impaired, while the independent and more delicately adjusted movements which employ preponderantly the smaller and more individualized muscular masses of the hand and foot, and serve to move the digits, especially the hallux and the thumb—in fact, just those movements which are represented most liberally in the limb area of the cortex—are extremely severely impaired, and, in some instances, are abolished. Several weeks after the operation electrical stimulation of these areas and convulsions induced by absinthe epilepsy both gave reactions which were little if at all different from those of the uninjured limbs. These observations seem to the author to point to the profound difference existing between the production of the finer movements of the limb in volition on the one hand, and by experimental stimulation of the cortex on the other. Their importance to the theory of cortical localization is obvious.

Upon section of a single sensory root no paralysis occurs, due to the fact of overlapping of the areas of peripheral distribution so that no area of anæsthesia is produced. But, even if an area of absolute anæsthesia be produced by the section of several roots, and even though this area be the highly sensitive palm, yet the impairment of movement resulting in the limb is comparatively slight if sensibility in an impaired degree be permitted to the adjacent parts. If, however, the whole hand or foot be rendered anæsthetic the impairment of movement is about as great as if the entire limb were affected; while conversely, if the whole series of sensory roots belonging to a limb be destroyed except those of the hand or foot, the impairment of motion is slight.

The experiments were applied to the study of the so-called muscular sensations. It is possible to sever the sensory fibres from the muscles of the limb without interfering to any great extent with those from the skin. In this case there is no appreciable defect of movement; conversely, if the sensory fibres from the skin are destroyed and those from the muscles are left intact, the defect in movement is extreme.

No disturbances in nutrition were demonstrated in the areas rendered anæsthetic. The degenerations in the cord showed that the fibres of Goll's column are mainly derived from the sensory roots from the lower limb, while the fibres of Burdach's column are derived largely from the dorsal roots from the upper limb. On the other hand, section of a short series of five dorsal and upper lumbar roots produced no ap-

preciable degeneration in Goll's column. Their upward path must be via the grey matter, and probably subsequently by one of the cerebellar tracts to the cerebellum.

C. J. H.

Race Differences in Reaction Time.[1]

It would, at first thought, seem natural to expect that prompt reaction to a stimulus would be associated with highly developed mental powers and perfect education. A moment's reflection would show that this is not the case. Strong intelligence implies a wide degree of coordination and education implies a development of inhibitory and selective processes. Both these tend to delay the psycho-motor reaction time and this may occur when the actual rate of translation of the stimulus is high.

Dr. Bache, having discovered that in the Indian and Negro races the reaction time is shorter, explains it by supposing that the lower automatic mechanism is more highly differentiated in the lower races and that in proportion to intellectual advancement there is a compensatory waning in the efficiency of the automatism of the individual. We question if it is necessary to seek so radical a difference as above indicated.

C. L. H.

Wellesly College Psychological Studies.[2]

The "Minor Studies" communicated by Mary W. Calkins embrace in the present instalment a brief discussion of the "continued story" by Mabel Learoyd and and notes on Synæsthesia by the editor. The former is a series of notes on a special form of imaginative process which in some form must be found in every experience. The degree to which the narrative element is disassociated from the ego seems to be the point requiring study. We look in vain in the paper for any analysis or suggestions as to the bearing of the facts though the latter are not wholly unsuggestive.

The statistics given are clearly valueless as there seems to be sufficent ambiguity as to the term "continued story" to quite invalidate the replies. Let us inquire, for example, whether the boy with a mechanical turn and who spends an hour or two each night in building a steamboat till sleep overpowers him, resuming the process on the following night has a continued story. He will reply "no," but the im-

---

[1]BACHE, R. M. Reaction Time with Reference to Race. *Psych. Rev.*, *II*, *5*.

[2]*Am. Journ. Psych.* VII, I.

aginative process is essentially the same as that of the school girl who constructs a story in which she as heroine passes through a variety of episodes with Prince Charming.

It seems that if a method could be found for measuring the extent to which the "story" is objectivized and projected clear of the ego and also the degree to which it is associated with purposive elements a pedagogic value would be acquired.

In the paper on synæsthesia the most valuable contribution is perhaps the very full list of questions carefully tabulated and arranged.

C. L. H.

Kraepelin's Psychologische Arbeiten.

The first number of this volume contains a paper by the editor on Psychological Experiments in Psychiatry, and one by A. Osborn entitled Experimental Studies as a Contribution to Individual-Psychology. Neither of these admits of synopsis, while the remaining paper is referred to elsewhere. The first "heft" is well-printed and forms a pamphlet of over 200 pages devoted to the department of experimental psychology requiring the most tedious experiments and involving the greatest demands on good judgement and insight. It is to be hoped that the subsequent numbers will fulfill the promise of the first.

C. L. H.

Influence of Fatigue on Psychical Processes.[1]

The results reached from a laborious study of bodily and mental fatigue are summarized as follows: Mental exercise of addition for one hour or physical exercise as in a two hours' walk results in a diminution of mental power—as evidenced in the time occupied in recognition, choice and association, and in the enfeeblement of memory and decrease of the amenability to practice. In the main, physical effort was more influential than mental, so that gymnastics and walking cannot be considered as refreshment from mental effort. After mental labor there were symptoms of motor fatigue, after physical of central motor excitability, the latter disappearing more quickly than the former. Great fatigue (night experiments) produced in contrast to others, a depression which continued several days.

The evidence seems to show what practical experience has often suggested, that the elements of mental fatigue are all corporeal. Practically, the beneficial effects of exercise lie on this side of excessive fatigue whether mental or muscular. C. L. H.

---

[1]BETTMANN, S. Psychologische Arbeiten. Herausg. v. Emil Kraepelin. *Heidelberg*, I, 1, 1895.

A Case for Diagnosis.

Though the interest in degeneracy as a popular fad seems to be on the wane, yet John Bryan's volume of "Fables"[1] may still possess some interest to the mental pathologist,—highly spiced as it is, it can hardly lay claim to serious recognition in any other quarter. The book would seem well adapted both in style and matter to furnish pabulum very acceptable to the disciples of Nordau. We do not presume to decide whether the author himself is degenerate, but his literary style certainly is so. Colloquialism could be condoned if it were a cloak for anything better; but it is difficult to see how the author expects to "have made the reader wiser, better, truer" by his tirades against all religion and conventional morality, and the fact that it is done up "on elegant cream paper, uncut edges front and bottom, bound in the new, tasteful styles of Buckram with stamped sides and back," does not materially help the matter. C. J. H.

The Physiology of Pain.[2]

The punctiform stimulation of the skin with gradually increasing stimuli establishes the presence of two thresholds of the stimulus, a lower one for the pressure sense, a higher one for pain. Pressure spots and pain spots are distinct, the former near the hair bulbs.

There are rather large areas of the body which are sensitive to pressure, but not to pain, and others which perceive only pain. The latter, accordingly, have only a single threshold of the stimulus, which need not lie higher than the threshold of pressure and indeed may lie considerably lower (cornea).

The author concludes, therefore, that sensations of pain are provided with special organs, pain spots and pain nerves.

In the second communication the free nerve-endings between the epithelial cells are regarded as the pain-termini. This receives corroboration from the fact that these are the only termini known in the cornea. The pressure spots are distinguished from the pain spots not only physiologically and anatomically, but by greater excitability by the oscillating electric current and by the peculiarity of being not constantly but rhythmically excited by the constant current. The relation of these

---

[1]Fables and Essays. By JOHN BRYAN of Ohio. *New York, The Arts and Lettres Co.*, 1895.

[2] M. v. FREY. Beiträge zur Physiologie des Schmerzsinns. *Bericht ü. Verh. kl. Sächs. Ges. d. Wiss. zu Leipzig.* Math.-Phys. Classe, 1894, 2, pp. 185-196; *Do.*, 1894, 3, pp. 281-296; *Do.*, 1895, 2, pp. 166-185.

spots to temperature spots is discussed in the third communication. The termini swellings (*endkolben*) described by Krause and Dogiel are regarded as cold termini. The nerve skeins (*Nervenknaeuel*) of Tomsa and Krause and Ruffini's termini are regarded as warm termini. Meissner's corpuscles are the tactile termini.

To our mind the introduction of so much purely hypothetical morphology does not promote confidence in either the physiological results or the conclusions deduced from them.

C. J. H.

Pain Nerves.

In the September Psychological Review Herbert Nichols severely criticises Dr. Strong's article in the July number because of its statement "that the evidence seems on the whole to indicate that pain impulses are exaggerations of tactile, heat and cold impulses, and are conducted by the same nerves." Mr. Nichols admits that there is not a particle of anatomical evidence for separate "pain fibres" but we think betrays ignorance of modern histology when he summarizes the objections to the Wundt theory as follows: "First the numerous cases, normal and pathological, of pain without accompanying sensations of touch, heat or cold. Next, its demand for a much more complicated and duplex arrangement of our sensory nervous systems—cranial as well as cord—than present anatomy gives any suggestion of." It is much to be questioned whether, as Mr. Nichols farther claims, the phenomena are "more reasonably explained by the very simple theory of pain nerves." If the recent remarkable advances in our knowledge of the cord have shown anything it would seem to be that the paths by which a stimulus may ascend from the dorsal roots are extremely complicated. There is abundant reason to assume that super-potent stimuli may find their way (a trifle more slowly) through multineuritic paths and reach other termini than normal sensory stimuli. There is a curious obscurity in the idea that an exaggerated stimulus will necessarily produce a sensation of the same kind as normal one. This implies a "specific energy" theory with decided limitations. We do not consider the phraseology of Dr. Strong's paper happy but it is certainly as easy to reconcile our present anatomical and physiological knowledge with a "shunt theory" as it is to find any opportunity for purely hypothetical pain nerves. The psychological bearing of the former has been already discussed by the writer in this Journal.

C. L. H.

Development of Associational Fibres of the Cortex.[1]

It is a well-known fact that the medullated fibres connecting the various parts of the cerebrum do not all appear at the same time in the course of embryonic development. Dr. Flechsig has one of his students at work endeavoring to complete our knowledge of the exact sequence. In a brief paper some of the results of this study as applied to the sensory connections are given. In the fœtus at full term the first associational bundles are developed in connection with those portions of the occipital lobes which communicate with the fillet and the ascending fibres from the pre-peduncle of the cerebellum. They comprise short arcuate fibres which apparently never extend farther cephalad than the central convolution and appear more distinctly in the upper regions than in the lower. Examination of the brain of a child of four weeks shows that there is a second cortical region aside from the central convolution which is characterized by the early appearance of well-developed associational systems. Its centre is in the region of the lamina perforata anterior and the inner olfactory convolution. From this point medullateded bundles go on the one hand to the thalamus and basal striata [coronal fibres], and on the other hand to other grey centres.

Above all, numerous medullated tracts pass into the septum pellucidum and the striæ Lancisii which end in the small grey masses on the dorsal surface of the callosum, and finally tracts to the uncinate gyrus. The most strongly medullated bundle, however, lies within the gyrus hippocampi passing caudad parallel to the surface from the cortex of the gyrus uncinatus in the form of radial fibres into the cortex of the gyrus hippocampi. Individual fibres may be followed up to the region of the splenium, course under the ventricle outward and thus come into the neighborhood of the rudimentary—poorly medullated—optic radiation, with which they possibly penetrate the corpora quadrigamina. This bundle is especially strong in that region of the gyrus hippocampi which, on the basis of comparative anatomy, is regarded as the olfactory centre, and there is in the whole brain no associational system which can be even remotely compared with it for size.

In view of the recent discovery that the olfactory cortex is phylogenetically so ancient, these facts acquire a special interest. The early appearance of the striæ Lancisii is especially suggestive after the dem-

---

[1] FLECHSIG, P. Zur Entwickelungsgeschichte der Associationssysteme im Menschlichen Gehirn. *Berichte ü. Verh. kl. Säch. Ges. d. Wiss. zu Leipzig.* Math.-Phys. Classe, 1894, 2.

onstration by Fish, Herrick and others and subsequently by G. Elliot Smith that these fibres are olfactory tracts, putting the olfactory lobes and the hippocampus in direct connection. Though this tract is so much reduced in man, yet its appearance cotemporaneously with the olfactory connections is a strong corroboration of the homology.

C. J. H.

Functions of the Retinal Rods.

Hering[1] has recently made several contributions to the so-called Purkinje's Phenomenon. When a red and a blue surface (whether the color be inherent or spectral) appear equally saturated and then the illumination is diminished the red becomes fainter and finally disappears. The same is true of yellow and green. The change is shown by experiment to reside in the eye which during accommodation to darkness becomes more sensitive to blue-green and less so to red-yellow. Even if the colors are unaltered and the general field is darkened the result is produced. The gradual disappearance of the colored components as against the colorless is the essence of the Purkinje phenomenon. The sensitiveness to white increases and to color decreases from the fovea toward the periphery of the retina. In the macula lutea the color sense alone prevails. Hering explains these phenomena on the basis of the different degrees of saturation with white of different colors and his familiar theory of color vision. Kries,[2] however, gives a much more complete and satisfactory discussion of the matter.

He shows first that if the illuminated spots are so small that their image falls within the macula the change in intensity is not produced by accommodation to darkness so long as fixation continues, i. e. so long as the image remains in the fovea where as we know only cones are found. By exclusion it is easily concluded that the rods alone are responsible for Purkinje's phenomenon. The rods then are characterized by (1) total color blindness, producing the sensation of colorless light only whatever the wave length, (2) by greater excitability to short and medium wave lengths, and (3) by a great adaptability to various intensities.

These conclusions stand in interesting harmony with those of M. Schultze (*Arch. f. mik. Anat.* II, 1866,) who showed that nocturnal animals and birds lack the cones. The sensation of white may, therefore, be produced either by the rods or by a suitable excitation of the trichro-

[1]Pflüger's Archiv. LX, p. 519, and LXI, p. 106.

[2]Ueber die Funktion der Netzhautstäbchen. *Zeitschrift f. Psych.* IX, 2.

matic cones. Concerning the fact discovered by Mrs. Ladd-Franklin and Dr. Ebbinghaus that white produced by union of different colors varies in intensity when the illumination varies, Kries says: The similarity of intensity prevailing for high intensities becomes altered on diminishing the intensity according to the rule that the mixture which has the greatest "rod-valence" then has overplus of colorless light. He really interprets Hering's white-valence as rod-valence and offers a valuable contribution to the physiologico-anatomical construction of color vision. The position lies between that of Helmholtz and Hering. The paper is too extended to be abstracted here and all interested should read the original. C. L. H.

The Optical Properties of the Medullary Sheath.[1]

This paper is chiefly significant because it illustrates a method of investigation which is as yet but little known. A study of the optical properties of medullated and non-medullated nerves shows that in polarized light with crossed Nicols and a gypsum plate interposed the medullated nerves transmit red, orange or yellow light, while the non-medullated nerves transmit violet, indigo or blue. The acuracy of this conclusion was checked by control preparations stained by the Weigert and the osmic acid methods. As applied to the optic nerve it appears that in animals born blind (rabbits) the nerves remain non-medullated until the eyes are open. The various sensory and motor nerves, associational tracts etc. show color differences at any given embryonic stage which enable one to judge of the extent of medullation and thus of the order in which they acquire their sheaths.

C. J. H.

The "Cajal's Cells" of the Human Cortex.[2]

In this contribution Dr. Retzius completes our knowledge of certain peculiar cells found in the so-called molecular layer of the cerebral cortex. These cells have been previously described by Cajal and Retzius in the rabbit, mouse, rat, and cat. This knowledge is now supplemented by a very exhaustive treatment of their structure in the human brain. Their development history has been worked out in a full

---

[1] AMBRONN, H. and HELD, H. Ueber Entwickelung und Bedeutung des Nervenmarks. *Berichte Verh. kl. Sächs. Ges. Wiss. zu Leipzig. Math.-Phys. Classe.* 1895, I.

[2] RETZIUS, GUSTAF. Weitere Beiträge zur Kenntniss der Cajal'schen Zellen der Grosshirnrinde des Menschen. 6 plates. *Biologische Untersuchungen.* N. F., VI, 2-3, 1894.

series of human fœtuses. They first appear in the fifth month and have been followed in their development up to birth. Oft-repeated attempts have failed to differentiate them in post-fœtal life in the human brain, though they are easily demonstrated in those of other mammals. The inability to secure perfectly fresh material is regarded as the cause of the failure and we may regard the forms given at birth as practically those of the adult, since this is true for the pyramidal and neuroglia cells of the brain.

In all the fœtal stages observed there is a common type for these cells; a cell body with its long axis at right angles to the brain surface lying in the molecular layer and usually rather more than half way between the layer of pyramidal cells and the brain surface. The processes are of two kinds, short processes ascending directly from the cell body to the surface where they end in tuberosities, and long tangential processes either running directly laterally from the cell or dipping to a deeper level there to turn in a tangential direction perhaps in several branches. Along the entire length of the tangential processes ascending processes rise to the surface, like the first mentioned processes. The cell bodies are sparsely distributed, but the fibres are very numerous and make up the major part of this layer. The author therefore suggests that this layer be named the layer of Cajal's cells in place of the now no longer applicable "molecular layer."

C. J. H.

The Sensory Organs of the Fins of Gurnards.[1]

The study of the central nervous system was purely incidental but the figures illustrate clearly the large excrescences to the dorsal cord due to the specialized development of the first three spinal nerves. We may add that very important assistance to a proper understanding of the brain segments and their homologies may be expected from a comparative study of these protuberances which, like the lobi vagi, occur sporadically among fishes. We already know that the cerebral hemispheres seem to have been called into being primarily by the emergence of one of the senses (smell) and are prepared to understand that anything which accelerates the development of a sensory segment in the cord may produce a like protuberance anywhere in the myelon. The nature of the connections and modifications resulting may well give us an important clue to the apprehension of the morphological significance of the brain segments. Of these matters the paper gives

[1] MORRILL, A. D. The Pectoral Appendages of Prionotus and their Innervation. *Journ. Mophology*, XI, 1.

no hint. The two cephalic pairs of "accessory lobes" are, in this case, associated with the first spinal, the second spinal arises from the third pair and the third from the five remaining. The sensory root of the third spinal is more than ten times as as large as the motor and it is from the three branches of this nerve that the free rays are innervated. The rays are at first associated with the others by a web which is absorbed during development, proving that the free rays are of secondary origin. The nerves in the free rays form a plexus beneath the surface of the epidermis. Nerve fibres from the plexus pass between the cells of the inner layer of the epidermis, where they divide, some ending free and others are directly connected with spindle cells that extend to the cuticle. The office of the free rays seems to be the detection of food and tactile sensation incident to locomotion.

C. L. H.

Edinger's Bericht.[1]

Edinger's admirable Review of the anatomical literature of Neurology for 1893 and 1894 is at hand. This work grows in importance from year to year until now it is well-nigh indispensible. The present number contains 54 large pages of closely printed matter. In the brief introduction the author congratulates the science on the number of investigators who are entering this field; but laments the growing tendency to publish brief communications, often hastily prepared, while the number of larger, monographic works is diminishing, and especially he utters a timely warning against the still greater evil of basing far-reaching generalizations on work of that fragmentary character.

C. J. H.

Physician's and Surgeon's Pocket Dictionary.[2]

This little book is really too brief both in the number and character of the definitions to be of much use to physicians or anybody else.

Anatomy of the Brain of Craniates.[3]

The author presents a variety of (chiefly anatomical) data from Petromyzon, dipnoid, and selachian brains in support of views

---

[1] EDINGER, L. Bericht über die Leistungen auf dem Gebiete der Anatomie des Centralnervensystem im Laufe des Jahres 1893 und 1894. Reprinted from *Schmidt's Jahrbücher*, CCXLVI.

[2] *Chicago: The Modern Press Publishing Co.*, 1895.

[3] STUDNICKA, Sitzb. königl. böhmischen Gesellsch. 1895.

recently presented by him in various preliminary articles. We notice little which is new and fear that his opponents will not find his morphological deductions in all respects satisfactory.

The figures of Ammocetes given may be profitably compared with Ahlborn's figures of Petromyzon. Studnicka recognizes the cephalic pallial fibres as a callosum. He finds two classes of cells in the cortex of the pallium, the larger resembling the pyramidal cells of other vertebrates. He concludes that in the Cyclostomata the hemisphere is but an appendage of the bulbus and has no other function than olfaction.

A chapter is devoted to the embryology, the most important point being that the two hemispheres arise independently from the lateral massive walls of the ventricle and not from a common proton. This as well as other facts brought out accords with the present writer's deduction based on the morphology and histology of the "basal lobes" of teleosts that these lobes represent the elements of a cortex as well as of basal lobes properly speaking. Studnicka maintains that in spite of some easily recognized evidences of degeneration the brain of Cyclostomata is the most primitive at our disposal. Difficulties are reached in construing the development of the Selachii, which contains many "cenogenetic peculiarities." We hope to give this whole subject a comparative review and await the remainder of the author's investigation before venturing a critique. C. L. H.

RECENT LITERATURE.

D'ABUNDO, G. Recherches ultérieurs sur les voies lymphatiques du système nerveux central. *Arch. ital. de biol.*, XXIII, 1-2, 1895.

ADAMKIEWICZ. Noch eine Bemerkung zu Flechsig's Mitteilung: Ueber ein neues Einteilungsprincip der Grosshirnoberfläche. *Neurol. Cent.*, XIV, 2, pp. 76-77. FLECHSIG, Bemerkung dazu. *Ibid.*, p. 77.

ADOLPHI, H. Ueber Variationen der Spinalnerven und Wirbelsäule anurer Amphibien. II. Pelobates fuscus Wagl. und Rana esculenta. *Morph. Jahrb.*, XXII, 4, 1895.

AGOSTINI. Sul peso specific delle varie regioni della corteccia cerebrale nei sani e negli alienati. *Riv. sperim. di freniatr.*, XX, 2, 1895.

ALEXANDER, GUSTAV. Beitrag zur makroskopischen Praeparation des häutigen Labyrinthes des Menschen. *Arch. Anat. u. Phys.*, Anat. Ab., 1895, 2-3.

AMBRONN, H. and HELD, H. Ueber Entwicklung und Beudeutung des Nervenmarks. 1 pl. *Ber. Verh. kl. Sach. Gess. d. Wiss. zu Leipzig.* Math.-Phys. Classe. 1895, 1.

D'ANTONA. Taglio esperimentale del trigemino alla emergenza del ponte. *Il Policlinico.* 15 June 1894.

ATHIAS. Cellules nerveuses encore épithéliales dans la moelle du têtard de grenouille. Mode de développement du neurone. *C. R. Soc. de Biol.*, 1895, 24, p. 540-542.

AZOULAY, L. Mécanisme des imprégnations metalliques dans la méthode de Golgi. Méthode de Golgi sur coupes. *C. R. Soc. de Biol.*, 1894, No. 34, pp. 839-841.

AZOULAY, L. Les nerfs du rein chez l'homme. —— Les nerfs du cœur chez l'homme. *Soc. de Biol.*, 21 April, 1894.

AZOULAY, L. Seconde note sur les nerfs du rein. *C. R. Soc. de Biol.*, 1895, 26, p. 590-591.

BABES. Ueber Nervenschlingen. *Atti dell' XI. congr. med. internaz. Roma.* 1894, II, Anat., pp. 93-94.

BABES, V. Sur une nouvelle forme de terminaison nerveuse ; anses terminales. *Roumaine méd.*, II, 4, p. 97.

BARTH, AD. Bericht über die Leistungen und Fortschritte im Gebiete der normalen und pathologischen Anatomie und Histologie, sowie der Physiologie der Gehörorganes und Nasenrachenraumes in der ersten Hälfte des Jahres 1894. *Zeits. Ohrenheilk.*, XXVI, 2-3, 1894, pp. 205-215.

BARTH, A. Bericht über die Leistungen und Fortschritte im Gebiete der normalen und patholog. Anat. u. Histol. sowie der Physiologie des Gehörorganes und Nasenrachenraumes in der zweiten Hälfte des Jahres 1894. *Zeits. Ohrenhk.*, XXVI, 4, 1895.

BASTIAN, H. CHARLTON. Note on the Relations of Sensory Impressions and Sensory Centres to Voluntary Movements. *Proc. Roy. Soc.*, LVIII, 349, 16 Aug., 1895.

BECHTEREW, W. V. Der hintere Zweihügel als Centrum für das Gehör, die Stimmung die Reflexbewegungen. *Neurol. Cent.*, XIV, 16, 1895.

BECHTEREW, W. V. Die Bedeutung der Combination der entwickelungsgeschichtlichen und der Degenerationsmethode mit Vivisectionen für die experimentelle Physiologie des Nervensystems und über die Rolle der zarten und Kleinhirnbundel in der Gleichgewichtsfunction. *Neurol. Cent.*, XIV, 16, 1895.

BEDDARD, FRANK E. On the Brain of Gulo. *Pr. Zool. Soc. London*, 1895, Pt. I.

BEDDARD, FRANK E. On the Brain in the Lemurs. *Pr. Zool. Soc. London*, 1895, Pt. I.

BEDDARD, FRANK E. On the Visceral Anatomy and Brain of Dendrolagus cennetti. *Pr. Zool. Soc. London*, 1895, Pt. I.

BENAVNENTE, D. Contribucion al estudio de la topografia cráneo-encefálica. *Rev. med. de Chile*, *Santiago*, XXII, pp. 221-227, 1894. 7 Pl.

BENEDICENTI, A. Recherches histologiques sur le systéme nerveux central et peripherique du Bombyx mori. *Arch. ital. de biol.*, XXIV, I, p. I-II, I pl., 1895.

BENEDIKT, M. Vergleichung des Schädelschläfen-Lappens der Tiere und des Menschen. *Atti dell' XI. congr. internaz.*, *Roma*, 1894, II, Anat., pp. 10-11.

BERDAL, H. Sur l'emploi combiné du bichromate de potasse et du sulfate de cuivre pour l'imprégnation des cellules du systéme nerveux central. *C. R. Soc. de Biol.*, 23 Feb., 1895, No. 7, p. 134.

BERDAL, H. Sur l'imprégnation des cellules du systéme nerveux central par les mélanges de bichromate de potasse et de sulfate de cuivre. Méthode derivée de la précédente, permittant de colorer à volonté dans les coupes de moelle soit les cellules et les cylindses d'axes, soit les gaines de myéline. *C. R. Soc. de Biol.*, 16 March, 1895, No. 10, pp. 185-186.

BERKLEY, HENRY J. The Condition of the Gemmules or Lateral Buds of the Cortical Neurodendron in Some Forms of Insanity. A Preliminary Note. *Johns Hopkins Hospital Bulletin*, VI, 49, April, 1895, p. 68.

BERNHEIMER, ST. Zur Anatomie des Oculomotorius. *Verh. Ges. d. Naturf. 66. Vers. Wien*, 1894, II, 2, pp. 214-215.

BERNHEIMER, S. Systematischer Bericht über die Leistungen und Fortschritte der Augenheilkunde im dritten Quartel 1894. *Arch. Augenhk.*, XXX, 2-3, 1895.

BERNSTEIN, J. Ueber die specifische Energie des Hörnerven, die Wahrnehmung binauraler (diotischer) Schwebungen und die Beziehungen der Hörfunction zur statischen Function des Ohrlabyrinthes. *Pflüger's Archiv*, LVII, p. 475.

BERNSTEIN, J. Ueber das angehliche Hören labyrinthloser Tauben. *Pflüger's Arch.*, LXI, p. 113.

BETHE, ALBRECHT. Der subepitheliale Nervenplexus der Ctenophoren. *Biol. Cent.*, XV, 4, pp. 149-145.

BETHE, ALBRECHT. Studien über das Centralnervensystem von Carcinus

Maenas nebst Angaben über ein neues Verfahren der Methylenblau-fixation. 3 pl. *Arch. Mik. Anat.*, XLIV, 4, pp. 579-622.

BETTONI, A. Quelques observations sur l'anatomie de la moelle allongée, du pont et des pedoncules cérébraux. *Arch. ital de biol.*, XXIII, 3, 1895, pp. 375-380.

BIANCHI. Sulla funzione dei lobi frontali. *Atti dell' XI. congr. internaz. Roma*, 1894, II, Phys., pp. 190-192.

BIANCHI, L. Sur le fonction des lobes frontaux. *Arch. Ital. de Biol.*, XXII, 3, p. 102, 1895.

BICKFORD, ELIZABETH E. The Hypophysis of the Calamoichthys calabaricus (Smith). *Anat. Anz.*, X, 15, 15 Mch., 1895. 7 Figs.

BIEDL, A. Experimentelle Durchschneidung des linken Corpus restiforme und der aufsteigenden Trigeminuswurzel. *Wiener klin. Woch.*, 1894, p. 863.

BIEDL. A. Ueber die spinale sog. aufsteigende Trigeminuswurzel. *Wien. klin. Woch.*, VIII, 33, 1895.

BIEDL, A. Absteigende Kleinhirnbahnen. *Neurol. Cent.*, XIV, 10-11. 1895.

BIELSCHOWSKY, MAX. Obere Schleife und Hirnrinde. *Neurol. Cent.*, XIV, 5, pp. 205-207.

BIETTI, A. Sulla distribuzione e terminazione delle fibre nervose nella coroidea. Nota prevent. *Boll. d. soc. med.-chir. di Pavia.* Ann. di Ottalmol., XXIV, p. 233, 1895.

BIRNBACHER. Ueber eine Farbenreaction der belichteten im unbelichteten Netzhaut. *Graefe's Arch. f. Ophth.*, XL, 5, p. 1.

BISCONS and MOURET. Note sur les effets de l'excitation du bout central du vague après arrachement du spinal. *Soc. de Biol.*, 8 Dec., 1894.

BLOCHMANN, F. Ueber freie Nervenendigungen und Sinneszellen bei Bandwürmern. *Biol. Cent.*, XV, 1, pp. 14-25, 8 Figs., 1895.

BOCCI. Contributo alla legge di Bell e Magendie circa le radici sensitive spinale. *Atti dell' XI. congr. internaz. Roma*, 1894, II, Phys. pp. 66-68.

BONNIER, P. Rapports entre l'appareil ampullaire de l'oreille interne et les centres oculomoteurs. *C. R. Soc. de Biol.*, 11 May, 1895.

BORUTTAU, H. Neue Untersuchungen über die am Nerven unter der Wirkung erregender Einflüsse auftretenden Erscheinungen. *Pflüger's Arch.*, LVIII, p. 1.

BORUTTAU, H. Fortgesetzte Untersuchungen über die elektrischen Erscheinungen am thätigen Nerven. *Pflüger's Archiv*, LIX, p. 47.

BOTAZZI, F. Le cerveau antérieur des Sélaciens. *Arch. ital. de biol.*, XXIII, 3, 1895.

BOUIN, P. Contribution à l'étude du ganglion moyen de la rétine des oiseaux. *Bul. Soc. sci. Nancy*, 1895, No. 1, pp. 8-12.

BOUIN, P. Contribution à l'étude du ganglion moyen de la rétine chez les oiseaux. *Jour. Anat. et Physiol.*, 1895, 4.

BRANDES, G. Ueber Aufnahme von Methylenblau im Tierkörper. *Abh. Naturf. Ges. zu Halle*, XIX, 1-2, 1893, pp. 81-82.

BRANDIS, F. Untersuchungen über das Gehirn der Vögel. III. Der Ursprung des N. Trigeminus und der Augenmuskelnerven. 1 pl. *Arch. Mik. Anat.*, XLIV, 4, pp. 534-555, 3 Mch., 1895.

BRAZZOLA, F. Contributo allo studio delle vie di senso, decorso e localizzazioni. *Bull. d. sc. men.*, (7) V, 9, 1894, p. 480.

BREGLIA, A. Su di un canale anomalo in un encefalo di feto di coniglia. *Giorn. Assoz. d. Med. e Natural.*, V, 1, 1894, pp. 65-78.

BROADBENT, WILLIAM. Brain Origin. *Brain*, LXX–LXXI, Summer and Autumn, 1895.

BROOKS, W. K. The Sensory Clubs of Condyli of Laodice. *Jour. Morph.* X, 1, 1895.

BRUCE, ALEX. On the Flocculus. *Brain*, LXX–LXXI, Summer and Autumn, 1895.

BRUCE, A. Illustrations of the Nerve Tracts in the Mid- and Hind-brain and the Cranial Nerves Arising therefrom. *Edinburgh and London, J. Y. Pentland*, 1895.

CAGNEY, JAMES. Ueber die Innervation der Abductoren wie Adductoren der Stimmbänder. *Deuts. Zeits. f. Nervenhk.*, VII, 1-2, 1895.

CAJAL, S. RAMON Y. New Ideas upon the Structure of the Spinal Cord in Man and Vertebrates. *Modern Med.*, IV, 4, April, 1895,

CAJAL, S. R. Y. Corps strié. *Bibliogr. Anatomique*, III, 2, Apr., 1895, pp. 58-63.

CAJAL, S. R. Y. Ganglions cérébelleux. *Bibliographie Anatomique*, III, 1, Feb., 1895, pp. 33-42; Extract from "*Annales de la Société espagnole d' histoire naturelle de Madrid.*

CAJAL, S. R. Y. L'anatomie fine de la moelle épinière. Atlas der pathologischen Histologie des Nervensystems redigirt von V. Babes. IV Lieferung. 35 pp, 8 pl. *Berlin, A. Hirschwald*, 1895.

CAJAL, S. R. Y. La retina dei Vertebrati. *Ann. di ottalmol.*., XXIV, 1, 1895.

CAMPBELL, J. A. Note on "Heavy Brains." *The Lancet*, No. 3746, 1895.

CAMUS, L. and GLEY, E. Action du système nerveux sur les principaux canaux lymphatiques. *C. R. ac. sc. Paris*, CXX, 13, pp. 747-750,

CAMUS, L. and GLEY, E. Recherches expérimentales sur l'innervation du canal thoracique. *Arch. physiol. norm. et pathol.* Année 27, S. 5, VII, 2, pp. 301-314.

CANNIEU, A. Remarques sur le nerf intermédiare de Wrisberg. *Compt. Rend.*, CXX, 16, 1895.

CARPENTER, E. G. Centren und Bahnen für die Kauerregung im Gehirn des Kaninchen. *Cent. f. Physiol.*, IX, 9, 27 July, 1895.

CARUS, PAUL. The Physiological Condition of Consciousness. *Jour. Comp. Neurol.*, V, July, 1895.

CAVAZZANI and MAUZA. Contributo allo studio della innervazione del fegato. *Arch. per le Scienze Med.*, 1894, No. 4.

CAVAZZINI, E. Le sympathique cervical concourt avec des fibres constrictrices et dilatatrices à l'innervation des vaisseaux cérébraux. *Arch. ital. biol.*, XXII, 2, 1894.

CAVAZZINI, E. Il simpatico cervicale concorre con fibre constritici e dila tatrici all' innervazione dei vasi cerebrali. *Atti dell' XI. congr. med. internaz. Roma*, 1894, II, Phys., p. 161.

CAVAZZANI, E. and MANCA, G. Contribution à l'étude de l'innervation du

foie. Les nerfs vaso-moteurs des ramifications portes hépatiques. *Arch. ital. de biol.*, XXIV, 1, 1895.

CHARCOT, J. M. and PITRES, A. Les centres moteurs corticaux chez l'homme. *Paris, Rueff & Co.*, 189 pp., 1895.

CHARCOT, J. M. and PITRES, A. Sur quelques points controversés de la doctrine des localizations cérébrales. *Arch. Clin. de Bord.*, III, 9, p. 389, 1895.

CHARPENTIER. Résistance apparente des nerfs soumis à l'excitation faradique. Conditions physiologiques influant sur la résistance apparente des nerfs faradisés. *Soc. de biol.*, 28 April, 1894.

CHARPENTIER, A. Conditions physiologiques influant sur la résistance apparente des nerfs faradisés. *C. R. Soc. biol.*, April, 1894, p. 348.

CHARPENTIER, A. Modifications de la résistance nerveuse par l'habitude aux excitations et par le travail musculaire. *C. R. Soc. biol.*, 5 May, 1894, p. 382.

CHARPENTIER, A. Résultats d'expériences sur la résistance nerveuse. Travail physiologique du nerf. *C. R. Soc. biol.*, 26 May, 1894, p. 421.

CHARPENTIER, A. Nouvelles mesures de la conductibilité électrique et du travail physiologique des nerfs. *Arch. de Physiol.*, (5) VI, 4, p. 792.

CHARPY, A. Système nerveux [suite]. 2 fasc. du t. III du Traité d'anatomie humaine publié sous la direction de P. Poiries. 1 vol., 8vo., pp. 35, 206 figs. *Paris, Battaille et Cie.*, 1895.

CAIARUGI, G. Lo sviluppo dei oculomotore e trigemello. Nota prevent. *Monit. zool. ital.*, V, 12, 1894, pp. 275-280.

CHIÁRUGI, G. Di un organo nervoso che va dalla regione del chiasma all' ectoderma in embrioni di mammifero. Nuove osservaz. e consideraz. 1 pl. *Monit. Zool. Ital.*, VI, 7, 1895.

CHIPAULT. Rapport des apophyses épineuses avec le contenu du canal rachidien. Thèse de Paris. *Nouv. Iconogr. de la Salp.*, VII, 4, p. 240.

CIACCIO, G. V. Observations microscopiques sur la structure intime des yeux des squilles et spécialement de la Squilla mantis. *Arch. ital. de biol.*, XVIII, 3, 1895.

CIRINCIONE, G, Metodo per determinare il peso e la estensione della substanza grigia e bianca del cervello. *Rif. med.*, X, p. 184.

CLIVIO, J. Contributo alla conoscenza delle terminazioni nervose dell' utero. Istit. ostetr.-ginecolog. di Pavia. *Pavia*, 1894, p. 25, 9 pl.

CLIVIO, J. Contribution à la connaisance des terminaisons nerveuses de l'utérus. *Arch. Ital. de Biol.*, XXIII, 1-2, 1895.

COGGI, A. Quelques faits concernant la crête neurale céphalique des Sélaciens. *Arch. ital. de biol.*, XXIII, 3, 1895.

COLELLA. Sulla histogenesi della nevroglia nel midollo spinale. *Arch. per le Scienze med.*, 1894.

COLLET, J. Les réactions électriques des nerfs sensoriels. *Gaz. hebd.*, XLI, 43, 1895.

COLLET, J. Les réactions electriques des nerfs sensoriels. *Gaz. Hebd.*, XLI, 41.

COLLINGE, WALTER E. The Unsymmetrical Distribution of the Cranial Nerves of Fishes. *Jour. Anat. and Phys.*, XXIX, N. S. IX, 3, pp. 352-355, April, 1895.

COLLINGE, W. E. Some Researches upon the Sensory Canal System of Ganoids. *Proc. Natur. Soc. Birmingham*, 1895, 7 pp.

COLUCCI, C. Sulla nevroglia retinica. Ricerche comparate d'istologica normale e d'istologia pathologica sperimentale. *Giorn. d. assoz. napolit. di med. e natur.*, V, 2, 1894.

COLUCCI, C. Sulla Nevroglia Retinica. *Atti d. R. Accad. medico-chirurg. di Napoli*, Anno 48, N. S. No. 2-3, 1895.

CORSO. Alcune esperienze sul cervelletto die pesci. *Atti dell' XI. congr. med. internaz. Roma*, 1894, Phys., p. 172.

COURMONT, F. Le Cervelet, organ physique et sensitif. *Paris, F. Alcan*, 1894.

COURTADE, D. and GUYON, J. F. Innervation des muscles de la vessie. *C. R. Soc. de Biol.*, S. 10. II, 27, 1895.

CRAMER, A. Beiträge zur feineren Anatomie der Medulla oblongata und der Brücke mit besonderer Berücksichtigung des 3.—12. Hirnnerven. *Jena, G. Fischer*, 1894.

CYBULSKI, N. and ZANIETOWSKI, J. Erwiderung auf Herrn Hoorweg's Abhandlung, betr. "Ueber die Nervenerregung durch Condensatorentladungen." *Pflüger's Archiv*, LIX, p. 421.

DANILEWSKY, B. Ueber die tripolare elektrische Reizung der Nerven. *Cent. f. Phys.*, IX, 12, 7 Sept., 1895.

DEBIERRE, C. and LEMAIRE, L. Sur l'innervation des muscles de la face. *C. R. Soc. de Biol.*, 1895, 25, pp 547-549.

DEJERINE, M. et Me. J. Sur les connexions du noyau rouge avec la corticalité. *C. R. Soc. de Biol.*, 30 Mch., 1895, pp. 226 230.

DEJERINE, M. et Me. J. Sur les connexions du ruban de Reil avec la corticalité cerebrale. *C R. Soc de Biol*, 6 April, 1895.

DEJERINE and SOTTAS. Sur la distribution des fibres endogènes dans le cordon postérieur de la moelle et sur la constitution du cordon de Goll. *C. R. Soc. de Biol.*, 1895, 21, pp. 465-469.

DEJERINE and SPILLER. Contribution à l'étude de la texture des cordons postérieurs de la moelle épinière. *C. R. Soc. de Biol.*, 1895, 27, pp. 622-628.

DELEZENNE, C. Le pneumogastrique contient-il des filets moteures pour la vessie et l'utérus? *C. R. Soc. de Biol.*, S. 10, II, 21, 1895.

DEYL, J. Ueber den Sehnerven bei Siluroiden und Acanthopsiden. *Anat. Anz.*, XI, 1, 8 Aug., 1895.

DISSE, J. Ueber Epithelknospen in der Regio olfactoria der Säuger. *Anat. Hefte, Halle, a-S.*, Abt. 1, H. 17 (B. 6, H. 1).

DIXON, A. FRANCIS. On the Development of the Branches of the Fifth Cranial Nerve in Man. *Proc. Roy. Soc.*, LVII, 343, May, 1895.

DOGIEL, A. S. Die Retina der Vögel, Erste Mittheilung. 2 pl. *Arch. Mik. Anat.*, XLIV, 4, pp. 622-648.

DOGIEL, A. S. Zur Frage über die Ganglien der Darmgeflecht bei den Saugetieren. *Anat. Anz.*, X, 16, 1 April, 1895, pp. 517-528, 6 figs.

DOGIEL, A. S. Eine geringe Abänderung der Golgi'schen Methode. *Anat. Anz.*, X, 17, 23 April, 1895, pp. 555-557.

DOGIEL, JOS. and GRAHE, E. Ueber die Wechselwirkung der Nn. vagi auf das Herz. *Arch. Anat. u. Phys.*, Phys. Ab., 1895, 3-4.

DOGIEL, A. S. Ein besonderer Typus von Nervenzellen in der mittleren gangliösen Sicht der Vogel-Retina. *Anat. Anz.*, X, 23, 10 July, 1895.

DONADSON, H. H. The Growth of the Brain. *London, Walter Scott*, 1895.

DUBOIS, R. Sur l'influence des centres nerveux sur la thermogénèse. *Soc. de biol.*, 8 Dec., 1894.

DURIG, ARNOLD. Das Formalin als Fixirungsmittel anstatt der Osmiumsäure bei der Methode Ramon y Cajal's. *Anat. Anz.*, X, 20, 13 June 1895.

DUVAL, M. Hypothèse sur la physiologie des centres nerveux. Theorie histologique du sommeil. *C. R. Soc. de Biol.*, 1895, 4, pp. 74-77.

EDINGER, L. Bericht über die Leistungen auf dem Gebiete der Anatomie des Centralnervensystem im Laufe des Jahres 1893 und 1894. Reprinted from *Schmidt's Jahrbücher*, CCXLVI.

EDINGER, L. Ueber die Entwickelung des Rindensehens. *Archiv f. Psychiat.*, XXVII, 3.

ELLIOT-SMITH, G. The connection Between the Olfactory Bulb and the Hippocampus. *Anat. Anz.*, X, 15, 15 March, 1895, pp. 470-474, 2 Figs,

ELLIOT-SMITH, G. The Morphology of the Smell-Centre. *Anat. Anz.*, XI, 2, 22 Aug., 1895.

ELLIOT-SMITH, G. Notes upon the Morphology of the Cerebrum and its Commissures in the Vertebrate Series. *Anat. Anz*, XI, 3, 30 Aug., 1895.

ELLIOT-SMITH, G. Jacobson's Organ and the Olfactory Bulb in Ornithorhynchus. 6 Figs. *Anat. Anz*, XI, 6, 2 Oct., 1895.

D' ERCHIA, FLORENZO. Contributo allo studio della struttura e delle connessioni del ganglio ciliare. [Contin. e fine.] *Monit. zool. ital.*, VI, 7, 1895.

EXNER, S. Entwürf zu einer physiologischen Erklärung der psychischen Erscheinungen. *Leipzig, F. Deuticke*, 1894, pp. 380.

FAJERSTAJN, J. Untersuchungen über Degeneration nach doppelten Rückenmarksdurchschneidungen. *Neurol. Cent.*, XIV, 8, 339, 1895.

FALK, F. Ueber combinirte Erregungszustände im Nervensystem. *Arch. f. Psychiat.*, XXVI, 3, p. 890.

FERRANNINI, A. Recenti ricerche sulla istofisiologia del midollo spinali. Rivista sintetica. *La riform. Med.*, XI, 122, 1895.

FERRIER, D. Les récentes recherche sur la physiologie du cervelet. Rectification et repliques. *Arch. ital. de biol.*, XXIII, 1-2, p. 217.

FICK, A. E. Ueber die Frage, ob zwischen Netzhäuten eines Augenpaares ein sympathischer Zusammenhang besteht. *Vierteljahrsschr. Naturforsch. Ges. Zurich*, XL, 1, 1895.

FICK, RUDOLF. Vergleichend Anatomische Studien an einem erwachsenen Orang-Utang. *Archiv f. Anat. u. Physiol. Anat. Abt.*, 1895, 1, pp. 1-97.

FISH, PIERRE A. The Central Nervous System of Desmognathus fusca. *Jour. Morphology*, X, 1, 1895.

FISH, PIERRE A. Formalin for the Preservation of Brains. *Jour. Comp. Neurol.*, V, July, 1895.

FLATAU, E. Atlas of the Human Brain and Description of the Course of the Nerve-Fibres. Transl. by W. NATHAN and J. H. CARSLAW. *Glasgow*, 1894, 4to, 8 pl.

FLATAU. Atlas du cerveau humain et du trajet des fibres nerveuses. Avec une préface de M. le Prof. Mendel. 4to, 10 pl., *Paris, G. Carré,* 1895.

FLATAU, EDWARD. Ueber die zweckmässige Anwendung der Golgi'schen Sublimatmethode für die Untersuchung des Gehirns des erwachsenen Menschen. *Arch. f. Mik. Anat.*, XLV, 1, 27 May, 1895.

FLATAU, E Ueber Färbung von Nervenpräparaten. *Dtsch. Med. Woch.*, XXI, 13, 28 Mch., 1895.

FLATAU, EDWARD. Ueber die Neuronenlehre. *Zeits. f. klin. Med.*, XXVIII, 1-2, 1895.

FLECHSIG, P. Zur Entwickelungsgeschichte der Associationssystem im menschlichen Gehirn. *Berichte über Verh. k. Sächs. Ges. d. Wiss. zu Leipzig*, 1894, 2.

FLECHSIG, PAUL. Gehirn und Seele. Rede. *Leipzig*, 1894, 4to., 28 pp.

FLEMMING, W. Ueber die Wirkung von Chromomiumsäure auf Zellkerne. *Arch. f. Mik. Anat.*, XLV, 1, 27 May, 1895, pp. 162-166.

FLEMMING, W. Ueber die Structure Spinalganglienzellen. *Verh. Anat. Ges. IX Versam. in Basal*, 1895.

FRANCAVIGLIA, M. C. L'encefalo dell' Halmaturus dorsalis Gray. Nota anatomo-comparativa. 1 pl. *Boll. soc. rom. per gli stud. zool.*, IV, 1-2, 1895.

FRANCOIS-FRANCK. Recherches sur l'innervation vasomotrice du pénis. Technique des explorations et principaux résultatas. *Arch. phys. norm. et path. ol.*, Année 27, S. 5, VII, 1, Jan. 1895.

FRANCOIS-FRANCK. Recherches sur l'innervation vaso-motrice du pénis. Topographie des nerfs constricteurs et dilateurs. *Arch. de physiologie*, 1895, No. 1, pp. 138-153.

FRASER, ALEC. On the Position of Anatomy in General and the Central Nervous System in Particular. *Tr. R. Ac. Med. Ireland*, XII, *Dublin*, 1895.

FRASER, ALEC. On the Lobus Olfactorius Impar. *Tr. R. Ac. Ireland, Dublin*, 1895.

FREX, M. V. Beiträge zur Physiologie des Schmerzsinns. *Berichte ü. d. Verh. kl. Sächs. Ges. d. Wiss. zu Leipzig.* Math.-Phys. Classe. 1894, 2; 1894, 3; 1895, 2.

FROHSE, F. Die oberflächlichen Nerven des Kopfes. *Berlin-Prag*, 1895.

FRORIEP, AUG. and BECK, WM. Ueber das Vorkommen dorsaler Hypoglossus würzeln mit Ganglion, in der Reihe der Säugetiere. *Anat. Anz.*, X, 21, 22 June, 1895.

FUCHS, L. Ueber die Function der unter der Haut liegenden Canalsysteme bei den Selachiern. *Pflüger's Archiv*, LIX, p. 454.

FUCHS, SIGMUND. Ueber den zeitlichen Verlauf des Erregungsvoranges im marklosen Nerven. *Sitz. Kais. Akad. Wiss. Wien.*, CIII, 8-10, 1894, pp. 1207-29

GAD, J. Der Energieumsatz in der Retina. Eine kritische studie. *Du Bois-Reymond's Arch.*, 1894, 5-6, p. 491.

GAD, J. Ueber eine leichte und sichere Methode die Nervenendigung an Muskelfasern und Gefässen nachzuweisen. *Arch. f. Anat. u. Physiol., Physiol. Abt.*, 1895, 1-2, pp. 202-208.

GAD, J. Ueber Nervenzellenfunctionen. *Neurol. Cent.*, XIII, 20, p. 745.

GAULE, J. Les propriétés trophiques du systéme nerveux. *Arch. Ital. de Biol.*, XXII, 2.

GAULE, J. Les propriétés trophiques du système nerveux. *Atti dell' XI. congr. med. internaz. Roma*, 1894, II, Phys., 57-70.

GEHUCHTEN, A. VAN. Le System Nerveux des Téléostéens. *La Cellule*, X, pp. 255-295. 3 pl. Abst. in *Am. Nat.*, XXIX, 339, Mch., 1895.

GEHUCHTEN, A. VAN. Le faisceau longitudinal postérieur. *B. acad. R. méd Belgique*, S: 4, IX, 2, Feb., 1895, pp. 323-360, 3 pl.

GEHUCHTEN, A. VAN. Le Bulbe Olfactif de l'homme. *Biblogr. Anat.*, III, 4, 1895.

GEHUCHTEN, A. VAN. De l'origine du pathétique et de la racine supérieure du trijumean. *B. ac. R. des sc., lettr. et des beaux arts de Belgique*, Année 65, S. 3, XXIX, 3, 1895.

GEHUCHTEN, A. VAN. Contribution à l'etude du faisceau de Meynert, ou faisceau rétro-réflexe. *Bull. Acad. Méd. Belg.*, 1894, VIII, 1, p. 114.

GIANNELLI, L. Applicazioni sul vivente del mio nuovo processo di topografia cranio-rolandica. *Proc.-verb. di ad. 27 Febbr. d. R. Accad. di fisiocritici Siena*, 1895.

GILIS, P. Le neurone ou l'unité nerveuse anatomique. *Nouveau Montpellier médical*, Jan. 1895.

GILIS, P. Les neurones dans la substance grise de la moelle épinière. *Nouveau Montpellier médical*, March, 1895.

GLEY, E. Sur l'innervation des vaisseaux lymphatiques. *Bull. du Mus. d'hist. nat. de Paris*, 1895, 3, pp. 127-128.

GMELIN. Die Geschmacksorgan der Thiere. *Rede. Monats. f. prakt. Thierheilk.*, VI, 6, p. 266, 1895.

GOLDING-BIRD, C. H. and SCHAEFER, E. A. Addendum to the article "On the Structure of the Fovea Centralis." *Intern. Monatsschr. Anat. u. Physiol.*, XII, 4. 1895.

GOLDZIEHER, W. Ueber die Beziehungen des Facialis zur Thränensecretion. *Cent. f. prakt. Augenhk.*, XIX, 5, 1895.

GOMEZ, O. J. Memoria sobre domonstración experimental de los centros visuales del cerebro. *An. d. R. Acad. sc. med., Madrid*, 1894, XIV, pp. 365-378.

DE GRAZIA. Ultime ricerche sulla fina anatomia della via motrice e sensitiva. Rivesta sintetica. *La riform. med.* XI, 148, 1895.

GREEFF, R. Die Morphologie und Physiologie der Spinnenzellen im chiasma, Sehnerven und in der Retina. *Du Bois-Reymond's Arch.*, 1894, No. 5-6, p. 550.

GREENWOOD, F. Imagination in Dreams and their Study. *London, John Lane*, 1894.

GRENACHER, H. Ueber die Retina der Cephalopoden. *Zool. Anz.*, XVIII, 480, 1895.

GRIGORESCU, G. Nouvelle méthod pour démontrer si la vitesse de la conductibilité nerveuse est ègale ou non dans les fibres sensitives et motrices chez l'homme. *C. R. Soc. Biol.*, 16 Feb., 1895.

GRIGORESCU and CONSTANTINESCU. Vitesse de la conductibilité sensitive dans la sciatique et dans la moelle épinière chez l'homme sain et chez l'ataxique. *C. R. Soc. Biol.*, 30 Mch., 1895.

GROSGLIK, A. Zur Physiologie der Stirnlappen. *Archiv f. Anat. u. Physiol., Physiol. Abt.*, 1895, 1-2, pp. 98-130.

GROSSMANN, M. Ueber die Wurzelfasern der herzhemmenden Nerven. *Verh. Ges. D. Naturf. 66 Vers. Wien*, 1894, II, 2.

GRUENBAUM, A. S. Note on the Degenerations following double transverse, longitudinal and and anterior cornual Lesions of the Spinal Cord. *Jour. of Physiol.*, XVI, 5-6, p. 368.

GRUETZNER, P. Ueber die chemische Reizung sensibler Nerven. *Pflüger's Archiv*, LVIII, p. 69.

GRUETZNER. Mikroscopische Querschnitte durch die Netzhaut zweier Frösche. *Jahresh. d. Ver. f. vaderländ. Naturk. in Württemberg*, Jharg. LI, Sb. p. cxvi-cxvii, 1895.

GUYON, J. F. Contribution à l'étude de l'hyperthermie centrale consécutives aux lésions du cerveau. *Arch. de méd. expérim. et d'anat. pathol.*, (1), VI, 5, p. 706.

HAMMER. Ueber Degeneration im normalen peripheren Nerven. *Arch. f. Mik. Anat.*, XLV, 1, 27 May, 1895, pp. 145-158.

HARTMANN, H. and CABOCHE, P. Nerfs d'appareil sphinctérien de l'anus. *Bull. soc. Anat. de Paris*, [5], IX, p. 210, 1895.

HASSE, C. Handatlas der sensiblen und motorischen Gebiete der Hirn- und Rückenmarksnerven. *Wiesbaden, J. F. Bergmann*, 1895.

HENSCHEN, S. E. Om den tekniska undersökningen af hjärnan. *Festskr. med. dokt. F. W. Warfvinge, Stockholm*, 1894.

HENSCHEN, S. E. Sur les centres optiques cérébraux. *Lyon, Georg*, 1895.

V. HERFF. Zur Frage des Vorkommens von Follikelnerven im Eierstock des Menschen. *C. Gynäkol.*, XIX, 5, 1895, pp. 126-127.

HERING, EWALD. The Specific Energies of the Nervous System. *Chicago, The Open Court Publishing Co.*, 1895.

HERRICK, C. L. The Histogenesis of the Cerebellum. *Jour. Comp. Neurol.*, V, 1, March, 1895, pp. 66-70.

HEYMANS, J. F. and DEMOR, L. Etude de l'innervation du coeur des Vertébrés à l'aide de la méthode de Golgi. *Arch. biol.*, XIII, 4, pp. 619-676, 25 pl.

HILL, ALEX. The Fascia Cinerea ; its Relation to the Fascia Dentata and the Nerves of Lancisi. *Proc. Roy. Soc.*, LVIII, 349, 16 Aug., 1895.

HIRSCH, M. Ueber Schlaf, Hypnose, und Somnambulismus. *Deutsche Med. Woch.*, XXI, 36, 5 Sept., 1895.

HIS. Ueber die frühesten Stufe der Gehirnbildung bei Wirbeltieren. *Atti dell' XI. congr. med. internaz. Roma*, 1894, II, Anat., p. 15.

HIS, W. Neue Gehirnmodelle von F. J. Steger. *Verh. Anat. Ges. IX Versam. in Basel*, 1895.

HOCHSTETTER, E. Ueber die Beziehuug des Thalamus opticus zum Seitenventrikel des Grosshirns. *Verh. Ges. D. Naturf. 66. Vers. Wien*, 1894, 2.

HUEFLER, EMIL. Ueber den Faserverlauf im Sehnerven des Menschen. *Deutsch. Z. f. Nervenhk.*, VII, 1-2, 1895.

IWANZOFF, N. Der mikroskopischen Bau des elektrischen Organes von Torpedo. *Bull. Soc. Imp. natural. Moscou*, 1894, 3, p. 358.

JACK, WM. R. On the Analysis of Voluntary Musular Movements by Certain new Instruments. *Proc. Roy. Soc.*, LVII, 343, May, 1895.

JACOB, CHRISLIEB. Ein Beitrag zur Lehre vom Schleifenverlauf (obere, Rinden-, Thalamusschleife). *Neurolog. Cent.*, XIV, 7, pp. 308-310.

JACOB, C. Unser Wissen von der sensiblen Leitungsbahn. *Münchener Med. Woch.*, 1895, 14, p. 336.

JACOBSEN, J. Ueber die Lage der Pyramidenvorderstrangfasern in der Medulla oblongata. *Neurol. Cent.*, XIV, 8, p. 348, 1895.

JACQUES, P. Les terminaisons nerveuses dans l'organ de la gustation. *La Méd. mod.*, 6 Oct., 1894.

JACQUES, P. Recherches sur les nerfs du cœur chez la grenouille et les Mammifères. *Jour. anat. et physiol.*, 1894, XXX, 6, pp. 622-648.

JAKOB, C. Atlas des gesunden und kranken Nervensystems nebst Grundriss der Anatomie, Pathologie und Therapie desselben. Lehmann's med. Handatlanten, Bd. IX. *Munich*, 1895.

JELGERSMA, G. Die sensiblen nnd sensorischen Nervenbahnen und Centren. *Neurolog. Cent.*, XIV, 7, pp. 290-300.

JAMMES, L. Sur la structure de l'ectoderme et du système nerveux des Platelminthes parasites (Trématodes et Cestodes). *C. R. Soc. de Biol.*, CXXI, 5, 1895.

JANOSICK. Quelques questions embryologiques concernant le système nerveux. *Casopis ceskych lekaru*, 1894, No. 20. Abs. in *Rev. Neurologique*, III, 4, 28 Feb., 1895.

KAISER. Ueber den Wert der vergleichend- anatomischen Untersuchung des Centralnervensystems. *Allg. Z. Psychiat. u. psych.-gerichtl. Med.*, LI, 4, 1894, pp. 835-837.

KARUSIN, P. "The Fibre Tracts of the Spinal Cord Ontogenetically Investigated." Dissertation. *Moscow*, 1894, pp. 86 [Russian].

KATZ, L. Ueber ein Verfahren, makroskopische Präparate des Gehörorganes durchsichtig zu machen. *Berlin. Klin. Woch.*, 1895, 19.

KAUFMANN. Noveaux faits relatifs au mécanisme de l'hyperglycemie et de l'hypoglycemie. Influence du système nerveux sur la glycosformation et l'hystolyse. *Comp. Rend.*, CXX, 4, p. 202, 1895.

KIES. Ueber das Gehirngewicht der heranwachsenden Menschen. *Corr. Bl. d. dtsch. anthropol. Ges.*, 1894, 10.

KLAATSCH, H. Ueber die Bedeutung der Hautsinnesorgane für die Ausschaltung per Skleroblasten aus dem Ektoderm. *Verh. Anat. Ges. IX Versam. in Basel*, 1895.

KLIPPEL and DURANTE. Des dégénérescences rétrogrades dans les nerfs périphériques et les centres nerveux. *Rev. de Méd.*, 1895, 1, 2, 4, 7, 8.

KLEINENBERG. Sullo sviluppo del sistema nervoso periferico nei molluschi. *Atti dell' XI. congr. med. internaz. Roma*, 1894, II, Anat., p. 37.

KLEMPERER, FELIX. Experimentelle Untersuchungen über Phonations-centren im Gehirn. *A. f. Laryngol. u. Rhinol.*, II, 3 and 9, 1895.

KOELLIKER, A. v. Ueber die feinere Anatomie und die physiologische Bedeutung des sympatischen Nervensystems. *Naturw. Rundschau*, X, 3-5; *Internat. med.-photogr. Monatsschr.*, I, 1894, p. 361, II, 1, 1895, p. 17.

KOELLIKER, A. v. Ueber das Vorkommen von Nervenzellen in den vorderen Wurzeln der Rückenmarksnerven der Katze. *Verh. Ges. D. Naturf., 66 Vers., Wien*, 1894, II, 2; *Neurol Cent.*, XIII, 20, p. 744.

KOELLIKER, A. v. Ueber die Nerven der Nebennieren. *Verh. Ges. D. Naturf. 66. Vers., Wien*, 1894, 2; *Neurol. Cent.*, XIII, 20.

KOELLIKER, A. v. Zum feinere Baue des Zwischenhirns und der Regio hypothalmica. *Verh. Anat. Ges.*, IX. *Versam., in Basel*, 1895.

KOHL, C. Rudimentäre Wirbelthieraugen. *III Bibliotheca Zoologica*, Heft 14, Nachtrag, 1894.

KOLISKO, A. and REDLICH, E. Schemata zum Einzeichnen von Gehirnbefunden. 50 pl., 9 figs., 8-vo., pp. 10. *Vienna, F. Deuticke.*

KOPP, P. Ueber die Vertheilung und das topograpische Verhalten der Nerven an der Hand der Fleischfresser. *Dtsch. Zeits. f. Thiermed.*, XXI, 3-4, p. 161, 1895.

KOSTER, W. Ueber die percipirende Schicht der Netzhaut beim Menschen. *A. Ophthal.*, XLI, 1, 1895.

KOSTER, W. Etude sur les cones et les batonnets dans la région de la fovea centralis de la rétine chez l'homme. *Arch. d'ophthal.*, 1895, XV, 7.

KRAUSE, W. Die Retina [Schluss]. IV. Die Retina der Säuger. Nachträge. *Internat. Monatsschr. f. Anat. u. Physiol.*, XII, 3, 1895, pp. 105-186, 1 pl.

KREUSER. Bau und Functionen des Centralnervensystems der Wirbeltiere. *Jahresh. d. Ver. f. vaderländ. Naturk. in Württemberg.*, LI, 1895.

KRIES, J. v. Ueber den Einflus der Adaption auf Licht- und Farbenempfindung und über die Function der Stäbchen. *Ber. d. Naturf.-Ges zu Freiburg i. B.*, IX, 2, p. 61.

KRISCHEWSKY. J. Zur Entwickelung des menschlichen Auges. *Verh. d. Würzburger Physik.-med. Ges.*, XXVIII, 5.

KRISCHEWSKY, J. Zur Entwickelung des menschlichen Auges, nebst Anhang: Zur Aetiologie der angebornen Lidkolobome. *Würzburg*, 1895, pp. 30.

KUENNEMANN, O. Ueber die Morphologie des Kleinhirns bei Säugetieren. *Erlangen*, 1895, 16 pp., 17 figs.

KUITHAN, D. WALTH. Die Entwickelung des Kleinhirns bei Säugetieren. *München. med. Abhdlng.*, 7 Reike, 24 figs., 40 pp.

KUITHAN, WALTHER. Die Entwickelung des Kleinhirns von Säugetieren, unter Ausschluss der Histogenese. *Sb. d. Ges. f. Morph. u. Physiol., München*, 1894, 1-3, *Munich*, 1895.

KUPFFER, C. v. Die Deutung des Hirnanhanges. *Sb. d. Ges. f. Morph. u. Physiol., München*, 1894, 1-3.

KYRIE, J. Die Segmentation des Sympathicus und seine Beziehungen zum cerebrospinalen Nervensystem. *Vienna*, 1894. Abs. in *Cent. f. Physiol.*, IX, 1, 6 Apr., 1895, p. 45.

LABORDE. Les hypothèses sur la physiologie du système nerveux à propos de la communicatiou de Mathias Duval. *C. R. soc. biol.*, S. 10, II, 7, pp. 121-123, 23 Feb., 1895.

LACHI, PILADE. Sul rapporto del talamo ottico col ventricolo laterale dell' emisfero cerebrale. *Anat. Anz.*, X, 17, 23 April, 1895, pp. 537-538.

LACHI, PILADE. La formalina come mezzo di fissazione in sostituzione all' acido osmico nel metodo di Ramon y Cajal. *Anat. Anz.*, X, 24, 19 July, 1895.

LAKE, RICHARD. Abnormality of the Chorda Tympani. *The Lancet*, No. 1723, 1895, p. 28.

LAMBERT. De l'infatigabilité des nerfs sécrétoires. *C. R. Soc. de biol.*, 16 June, 1894.

LANGDON, FANNY E. The Sense Organs of Lumbricus agricola Hoffm. *Jour. Morph.*, XI, 1, 1895, 2 pl.

LANGLEY, J. N. Note on Regeneration of Preganglionic Fibres of the Sympathetic. *Jour. of Physiol.*, XVIII, 3, 1895.

LANGLEY, J. N. and ANDERSON, H. K. On the Innervation of the Pelvic and Adjoining Viscera, Pt. I. The Lower Portion of the Intestine. *Jour. of Physiol.*, XVIII, 1-2, 1895.

LAQUER, L. Hirnerscheinungen bei heftigen Schmerzfanfällen. *Arch. f. Psychiat.*, XXVI, 3, p. 791.

LEE, ARTHUR BOLLES. Formol, or Formaldehyde? *Anat. Anz.*, XI, 8, 24 Oct., 1895.

LEUBUSCHER and TEKLENBURG, A. Ueber den einfluss des Nervensystems auf die Resorption. *Virchow's Arch.*, (13) VIII, 2, p. 364.

LEVY-DORN, MAX. Zur Frage von dem verschiedenen Verhalten verschiedener Nerven, bezw. ihrer Endigungen gegen denselben Reiz. *Archiv f. Anat. u. Physiol., Physiol., Abt.*, 1895, 1-2, pp. 198-200; *Cent. f. Nervenhk.*, XVII, 12, p. 630.

LOEB, JACQUES. Beitrag zur Gehirnphysiologie der Würmer. *Pflüger's Arch.*, LVI, pp. 247-269.

LUCIANI, L. I recenti studi sulla fisiologia del cervelletto. Rettificazioni e repliche. *Riv. sperim. di freniatr.*, XXI, 1, 1895.

LUCIANI, L. Ueber Ferrier's neue Studien zur Physiologie des Kleinhirnes. Kritik u. Berichtigung. *Biol. Cent.*, XV, 9-10, 1895.

LUGARO, ERNESTO. Sull' origine di alcuni nervi encefalici (V, VI, VII, VIII). *Arch. di ottalmolog.*, II, 6, 1894.

LUGARO, E. Sulla struttura del nucleo dentato del cervelletto nel' uomo. *Monit. zool. ital.*, VI, 1, p. 5.

LUGARO, E. Sulle cellule d'origine della radice discendente del trigemino. *Arch. d. ottal.*, *Palermo*, II, pp. 116-119, 1894-5.

LUGARO, E. Sur les cellules d'origine de la racine descendente du trijumeau. *Arch. ital. de biol.*, XXIII, 1-2, p. 78, 1895.

LUGARO, E. Sur les connexions entre les éléments nerveux de l'écorce cérébelleuse, avec considérations générales sur la signification physiologique des rapports entre les éléments nerveux. *Arch. ital. de biol.*, XXIII, 1-2, p. 86.

LUGARO, E. Ueber die Verbindung der nervösen Elemente der Kleinhirn rinde unter einander, mit allgemeinen Bermerkungen über die physiologische Bedeutung der Rapporte zwischen den nervösen Elementen. 2 pl. *Untersuch. z. Naturlehre d. Menschen u. d. Tiere*, XV, 5-6, 1895.

LUGARO, E. Sulle modificazioni delle cellule nervose nei diversi stati funzionali. 9 figs. *Lo Sperimentale*, XLIX, 2, 1895.

LUYS, J. Etat Anatomique du cerveau d'un sujet ayant succombé pendant le coit (procédés de conservation de diverses pièces anatomiques). *Ann. psychiat. et d'hypnol.*, *Paris*, N. S., IV, 1894, pp. 257-259.

LUYS, J. Nouvelle recherches sur la structure du cerveau et l'agencement des fibres blanches de la substance cérébrale. *Ann. de psychiatr. et d'hypnolog.*, *Paris*, 1894, N. S. IV, pp. 321-324.

LUYS, J. Nouvelles fibres antero-posterieures de la region protuberantielle. *C. R. Soc. de Biol.*, 25 May, 1895.

LUYS. Catalogue d'une collection de cerveaux nomifiés. *C. R. Soc. de Biol.*, 11 May, 1895.

LUYS, J. Description d'un faisceau de fibres cérébrales descendantes allant se pedre dans les corps olivaires [faisceau cerebro-olivaire]. *C. R. Soc. de Biol.* 1895, 25.

LUYS, J. De la méthode du clivage et du moulage appliquée à l'etude du système nerveux. *C. R. Soc. de Biol.*, 1895, 26.

LYDSTON, JAMES A. The Relationship between the Eyes and the Brain. *Jour. Am. Med. Assoc.*, XXV, 19, 9 Nov., 1895.

MAGINI, G. L'orientation des nucléoles des cellules nerveuses motrices dans le lobe électrique de la torpille, à l'état de repos et à l'état d'excitation. *Arch. ital. de biol.*, XXII, 2, 1894, pp. 212-217.

MANDL, L. Ueber Anordnung und Endigungsweise der Nerven im Ovarium. *Arch. f. Gynäkol.*, XLVIII, 2, p. 376, 1895.

MANDL, L. Zur Frage des Vorkommens von Folikelnerven im Eierstocke des Menschen. Erwiderung an Prof. v. Herff. *Cent. f. Gynäkol.*, XIX, 8, p. 214, 1895.

MANOUVRIER, L. On the Brain of a young Fuegian. *Rep. 64 Meet. Brit. Asso. Adv. of Sc., Oxford*, 1894.

MANZZARELLI, G. Sull' origine del simpatico nei vertebrati. *Atti dell' XI. congr. med. internaz, Roma*, 1894, II, Anat. pp. 67-68.

MANZZARELLI, G. Sull' origine del simpatico nei Vertebrati. *Atti della R. Acc. dei Lincei*, 1894, II Sem., No. 8, p. 269.

MARAGLIANO, E. La dottrina dei neuroni. *Gazz. degli osped*, XVI, 36-39, 1895.

MARCUS, HENRY. Application of the Weigert-Pal method of staining to the nervous system hardened in formol. *Neurol. Cent.*, 1895, No. 1.

MARIE, R. Durcissement du système nerveux, méthode rapide par le formol. *La Presse méd.*, 15 Jan., 1895, pp. 11-12.

MARINESCO, G. Des connexions du corps strié avec le lobe frontal. *C. R. Soc. de Biol.*, S. 10. II, 4, pp. 77-78, 1895.

MARINESCO, G. Atrophies tertiaries d'origine centripète. *C. R. Soc. biol.*, 1895, 12, pp. 240-242.

MARSCHAL, CHARLES D. On the Changes in Movement and Sensation produced by Hemisection of the Spinal Cord in the Cat. *Proc. Roy. Soc.*, LVII, 343, May, 1895.

MARTIN, P. Zur Entwickelung der Gehirnfurchen bei Katze und Rind. *Arch. f. wiss. u. prakt. Thierhilk.*, XXI, 1, p. 1, 1895.

MATTE, F. Ein Beitrag zur Frage nach dem Ursprung der Fasern des Nervus acusticus. *Arch. f. Ohrenheilk.*, XXXIX, 17, p. 1, 1895.

MATTE, F. Experimenteller Beitrag zur Physiologie des Ohrlabyrinthes. *Pflüger's Archiv*, LVII, p. 437.

MELLUS, E. LINDEN. Experimental Degenerations following Unilateral Lesions of the Cortex Cerebri in the Bonnet Monkey [Macacus sinicus]. *Proc. Roy. Soc.*, LVIII, 350, 4 Sept., 1895.

MEYER, ADOLF. Zur Homologie der Fornixcommissur und des Septum

lucidum bei den Reptilien und Säugern. *Anat. Anz.*, X, 15, 15 Mch., 1895, pp. 474-482.

MICHAEL, A. D. On the Form and Proportions of the Brain in the Oribatidæ and in some other Acarina. *Jour. R. Micr. Soc.*, Pt. III, 1895.

MICKLE, W. JULIUS. Abnormal Brain Convolutions. *Alienist and Neurologist*, XVI, 4, Oct. 1895.

MIDDLEMASS, J. A heavy Brain. *The Lancet*, No. 3745, 1895.

MIES. Ueber das Gehirngewicht des heranwachsenden Menschen. *Correspondenzbl. deuts. Ges. Anthropol., Ethnol., u. Urgesch.*, 1894, No. 10, pp. 157-160.

MILLS, CHARLES K. Cortical Localization in the Light of Recent Researches into the Minute Anatomy of the Cortex. *Jour. Nerv. and Ment. Disease*, N. S. XX, 9, Sept., 1895.

MINGAZZINI, G. Ueber die gekreuzte cerebro-cerebellare Bahn. *Neurol. Cent.*. XIV, 15, 1895.

MINGAZZINI. Il cervello in relazione con i fenomeni psichici. *Turin, Fratelli Bocca*, 1895, pp. 200, 43 figs.

MIRTO, D. Sulla fina anatomia del tetto ottico dei pesci teleostei e sull' origine reale del nervo ottico. *Riv. sperim dè fteniatr.*, XXI, 1, 1895.

MISLAWSKY, N. Sur le role physiologiques des dendrites. *C. R. Soc. de Biol.*, 1895, 23.

MONDINO, C. Le odierne cognizioni sulla istofisiologia del sistema nervoso. Prolus. alle lez. di suoplenza di clinica psichiatr. per l'anno 1895. *Palermo, Zempo*, 1895, 24 pp.

MONTI, RINA. Contributo alla conoscenza dei nervi del tubo digerente dei pesci. *Ist. lombard. di sc. e lettere. Rend.*, S. 2, XXVIII, 12-13, 1895.

MONTI, RINA. Innervazione del tubo digerente dei pesci ossei. *Boll. scientif.*, XVII, 1, 1895.

MOORHEAD, J. HERBERT. Report of Investigations on the Spinal Cord. Level of Termination of Spinal Cord. *Trans. Roy. Acad. Med. in Ireland, Dublin*, XII, 1894.

MORAT, J. P. Ganglions et centres nerveux. *Arch. f. phys. norm et pathol.*, Année 27, S. 5, VII, 1, Jan., 1895, pp. 200-205.

MORAT, J. P. Remarques sur le mode d'action des poisons nerveux. A propos d'une communication anterieure de M. Mathias Duval. *C. R. Soc. de Biol.*, 16 Feb., 1895.

MORAT. Sur l'innervation du pancréas. *Gaz. des hopitaux de Toulouse*, VIII, p. 371, 1894.

MORGAN, C. LLOYD. Introduction to Comparative Psychology. *Contemporary Science Series, Walter Scott & Sons, London.*

MORGENSTERN, S. Weiters über das Vorkommen von Nerven in den harten Zahnsubstanzen und über eine Methode, sie aufzufinden und zu conserviren. *Dtsch. Monats. f. Zahnheilkunde*, XIII, 3, p. 111, 1895.

MORIN, CH. Note sur de fonctionnement du système nerveux à l'occasion des travaux histologiques de Ramón y Cajal et des remarques théoriques de MATH. DUVAL. *C. R. Soc. biol.*, S. 10, II, 8, p. 140, 1895.

MOTT, F. W. and SHERRINGTON, C. S. Experiments upon the Influence of Sensory Nerves upon Movement and Nutrition of the Limbs. Preliminary Communication. *Proc. Roy. Soc.*, LVII, 343, May, 1895.

MUENZER, EGMONT, and WIENER, H. Beiträge zur Anatomie und Physiologie des Centralnervensystems. I. Mitt. Ueber die Ausscheidung des Lendenmarkgrau. *Arch. exper. Pathol. u. Pharmakol.*, XXXV, 2-3, pp. 113-128, 2 pl.

MUENZER, EGMONT, and WIENER, H. Beiträge zur Anatomie des Centralnervensystems. *Prag. med. W.*, XX, 14, pp. 143-145, 5 figs.

DE NABIAS, P. Recherches histologiques et organologiques sur les centres nerveux des gastèrpodes. Thesis. *Paris*, 1894, pp. 195.

NAGEL, W. A. Ein Beitrag zur Kenntniss des Lichtsinnes augenloser Thiere. *Biol. Cent.*, XIV, p. 810, 1894.

NAGEL, W. A. Experimentelle sinnesphysiologische Untersuchungen an Coelenteraten. *Pflüger's Arch.*, LVII, p. 495, 1894.

NEUMANN, D. Experimentelle Untersuchungen über den fineren Mechanismus der Kehlkopfmusculatur. *Experim. Studien a. d. A. Inst. d. Univ. Budapesth. Wiesbaden*, 1895, pp. 204.

NEUMANN, OTTO. Die Gall'sche Schädellehre und die neuern Untersuchungen über die Function des Gehirns. *Die Aula*, I, 11-12, 1895.

NEUMAYER, LUDWIG. Histologische Untersuchungen über den feineren Bau des Centralnervensystems von Esox Lucius mit Berücksichtigung vergleichend-anatomischer und physiologischer Verhältnisse. 1 pl. *Arch. Mikr. Anat.* XLIV, 3, pp. 345-366, 16 Feb., 1895.

NISSL, FRANZ. Der gegenwärtige stand der Nervenzellenanatomie und Pathologie. *Cent. f. Nervenhk. u. Psych.*, XVIII, N. F. V, Jan., 1895, pp. 1-21.

NISSL, FRANZ. Ueber die Nomenklatur in der Nervenzellen-anatomie und ihre nächsten Ziele. *Neurolog. Cent.*, XIV, 2, 3, 1895.

NUSSBAUM, M. Ueber den Verlauf und die Endigung periperer Nerven. *Verh. Anat. Ges. IX Versam.*, *in Basel*, 1895.

NUTT, F. W. Experimental Inquiry upon the different Tracts of the Central Nervous System. *Rep. 64 Meet. Brit. Assoc. for Advanc. of Sci., at Oxford, 1894*, pp. 809-810.

OBERSTEINER. Die neuer Forschungen auf dem Gebiet des Centralnervensystems, kritisch beleuchtet. *Wiener Med. Woch.*, XLV, 12, p. 524.

ODDI. Sul centro spinale dello sfintere del coledoco. *Atti dell' XI congr. med. internaz.*, *Roma*, 1894, II, Phys., pp. 195-196.

ODDI, R. Sur le centre spinal du spincter du cholédoque. *Arch. ital. de biol.*, XXII, 3, p. 106, 1895.

OEHL, E. De l'influence de la chaleur sur la vitesse de transmission de l'excitation dans les nerfs sensitifs de l'homme. *Arch. ital. de biol.*, XXI, 3, 1894.

ONODI, A. Die Phonation im Gehirn. *Berliner klin. Woch.*, 26 Nov. 1894, p. 1089.

ONODI, A. (a) Die Phonationscentren im Gehirn; (b) Das Verhältnis des Accessorius zur Kehlkopfinnervation. *Verh. Ges. D. Naturf.*, *66. Vers. Wien, 1894*, II, 2, p. 282.

ONODI, A. Die Innervation des Kehlkopfes nach eigenen anatomischen, physiologischen und pathologischen Untersuchungen. *Wien*, *A. Hölder*, 1895. 92 pp., 4 pl. and 10 figs.

ONUF [ONUFROWICZ], B. The Biological and Morphological Constitution of Ganglionic Cells, as influenced by Section of the Spinal Nerve roots or Spinal Nerves. To which is appended some remarks on localization. *Journal of Nervous and Mental Disease*, XX, 10, Oct., 1895.

ORRU, E. La terminazione nervosa nei peli. *Boll. R. acc. med. di Roma*, XIX, 7, p. 762.

OSERETZKOWSKY. Beiträge zur Frage vom centralen Verlaufe des Gehörnervs. *Arch. Mik. Anat.*, XLV, 3, pp. 450-463.

OSTROUMOW, P. Die Nerven der Sinushaare. *Anat. Anz.*, X, 24, 19 July, 1895.

OSTWALD, W. Chemische Theorie der Willenfreiheit. *Ber. Verh. kl. Sächs. Ges. d. Wiss. zu Leipzig.* Math.-Phys. Classe. 1894, 3.

OTT, J. A Vesical Detrusor Centre in the Cerebral Peducles. *Med. Bul., Philadelphia*, XVI, 1894, pp. 410-412.

OTT, J. Contributions to the Physiology and Pathology of the Nervous System. Part XII. *Philadelphia*, 1892 to 1894.

OTTOLENGHI. La sensibilita in rapporto all' eta. *Atti R. Accad. da Fisiocritica in Siena*, 1894.

PALADINO. Sul modo di comportarsi di alcune fibre delle radici dorsali nel midollo spinale e sugli effetti che conseguitano alla recisione di queste. Contribuzione isto-sperimentale. *Atti dell' XI. congr. med. internaz. Roma*, 1894, II, Phys., pp. 56-57.

PALADINO, G. Gli effetti della recisione delle radici sensitive del midollo e loro interpretazione. *Rend. Accad. di sc. fische e matem.*, Anno 33, S. 2, VIII, 1894.

PALADINO, G. Les effets de la résection des racines sensitives de la moelle épinère et leur interprétation. *Arch. ital. de biol.*, XXIII, 1-2, P. 146, 1895.

PANDI, K. Du mecanisme cortical des phenomenes reflexes. *Paris, G. Steinheil*, 1895.

PARKER, G. H. The Retina and Optic Ganglia in Decapods, especially in Astacus. *Mittheilungen a. d. zoologischen Station zu Neapel*, XII, I, 1895.

PARKER, G. H. and FLOYD, R. The Preservation of Mammalian Brains by Means of Formol and Alcohol. *Anat. Anz.*, XI, 5, 28 Sept., 1895.

PAVLOW, J. Note bibliographique sur les nerfs sécrétoires du pancréas. *Arch. sc. biolog. publ. par l'instit. imp. de méd. expérim. à St. Pétersbourg*, III, 2, 1892.

PAWLOWA, M. Zum Bau des Eingiweidenervensystems der Insecten. *Zool. Anz.*, XVIII, 469, p. 85, 1895.

PAWLOWSKY. Sur la structure de la moelle épinière de l'Esturgeon Sterlet. *C. R. Soc. de Biol.*, 1895, 23.

PELI, G. L'indice cerebrale nei sani di mente e negli alienati. Osservationi in cinquecenio settanta individui d'ambo i sessi. *Arch. per l'antropol.*, XXIV, 3.

PELLIZZI, G. B. Sul decorso nel bulbo, nel cervello posteriore e nel cervelletto delle fibre degenerate in linea ascendente nei fasci periferici del cordone antero-laterale, e sui rapporti che contraggono i resti dei cordoni posteriori col corpo restiforme. *Annali di Freniatria*, V, 1, May, 1895, pp. 53-94, 2 pl.

PELLIZZI, G. B. Sur les dégénérescences secondaires, dans le système ner-

veux central, à la suite de lésions de la moelle et de la section des racines spinales. Contribution à l'anatomie et à la physiologie des voices cérébelleuses. *Arch. Ital. de biol.*, XXIV, 1, 1895.

PELLIZZI, G. B. Nuove ricerche sperimentali sulle degenerazioni secondarie spinali. *Annali di Freniatria*, V, 1, May, 1895, pp. 27-53, 1 pl.

PFEIFFER, O. Untersuchungen über die Lage, Ausdehung und Eigenschaften des cerebralen regulatorischen Herznervencentrums. Inaug.-Diss., *Giessen*, 1894.

PICK, A. Experimentell-anatomische Untersuchungen über die topographischen Beziehungen zwischen Retina, Opticus-und gekruztem Tractusquerschnitt biem Kaninchen. *Verh. Ges. D. Naturf., 66. Vers. Wien*, 1894, II, 2, pp. 175-176.

PISENTI, G. Sulla interpretazione da darsi ad alcune particolarità istologiche della glandula pituitaria. *Gazz. degli osped.*, Anno XVI, 50, 1895.

PIZON, A. Evolution du système nerveux et de l'organe vibratile chez les larves d'Ascides composées. *Comp. Rend.*, CXX, 8, p. 462, 1895.

POLIMANTI. Distribuzione funzionale delle radici motrici nei muscali degli arti. *Accad. med. di Genova*, 1894.

POLIMANTI, O. Sur la distribution fonctionelle des racines motrices dans les muscles des membres. *Arch. ital. de biol.*, XXIII, 3, 1895.

POLIS, A. Recherches expérimentales sur la commotion cérébrale. *Rev. de chir.*, XIV, 4 and 8.

POPOFF, N. M. Ueber den Verlauf des Nervenfaserbündles, das unter dem namen Conductor sonorus bekannt ist. *Dts. Zeits. f. Nervenhk.*, VII, 1-2, 1895.

PORTER, W. T. The Path of the Respiratory Impulse from the Bulb to the Phrenic Nuclei. *Jour. of Physiol*,, XVII, 6, 1895.

PORTER, W. T. The Part of Inhibition in the Physiology of Respiration. *Jour. Nerv. and Mental Disease*, N. S. XX, 8, Aug., 1895.

RABL, HANS. Notiz zur Morphologie der Geschmaksknospen auf der Epiglottis. *Anat. Anz.*, XI, 5, 28 Sept., 1895.

RACOVITZA, EMILE G. Sur le lobe encéphalique des Euphrosines. *C. R. ac. de sc. Paris*, CXIX, 26, 1894.

RACOVITZA, EMILE G. On the cephalic Lobe of Euphrosine. *Ann. and Mag. Nat. Hist.*, S. 6, XV, 87, pp. 279-281.

RAMON, P. Investigaciones micrograficas su el encefalo de los batracios y reptiles, etc. *Zaragoza*, 1894.

RANVIER, L. Des nerfs vasomoteurs des veines. *C. R. Acad. des sciences*, CXX, 1, 1895, pp. 19-20.

RAUGE, P. Le canal incisif et l'organe de Jacobson. *Arch. internat. de laryngol.*, VII, 1894, pp. 208-228.

REGNAULT, F. Les récentes decouvertes sur les cellules psychiques. *Le Naturaliste*, 1 Feb., 1895, No. 190, pp. 22-35.

REJSEK, J. L'entrée du nerf optique chez quelques rongeurs, "genus Sciurini." *Bibliogr. Anatomique*, III, 2, Apr., 1895, pp. 74-84, 1 pl.

RENAUT. Sur les cellules nerveuses multipolaires et la théorie du "neurone" de Waldeyer. *Bull. Acad. Méd.*, [3], XXXIII, 9, p. 207, 1895; *Le Bull. méd.*, IX, 17, pp. 193-195, 1895.

RENAUT. Contribution à l'étude de la constitution de l'articulation et de la conjugaison des neurones. *La Presse méd.*, 7 Aug., 1895.

RETZIUS, GUSTAV. Biologische Untersuchungen, N. F., VI, 32 pl. *Jena, G. Fischer*, 1895. Contents:

Die Neuroglia des Gehirnes beim Menschen und bei Säugetieren.

Weitere Beiträge zur Kenntniss der Cajal'schen Zellen der Grosshirnrinde des Menschen.

Ganglion ciliare.

Die embryonale Entwickelung der Rückenmarkselemente bei den Ophidiern.

Die Endigungsweise des Gehörnerven bei den Reptilien.

Die Riechzellen der Ophidier in der Riechschleimhaut und im Jacobson'schen Organ.

Zur Entwickelung der Zellen des Ganglion spirale acustici und zur Endigungsweise des Gehörnerven bei den Säugetieren.

Ueber den Bau des Glaskörpers und der Zonula Zinnii im Auge des Menschen und einiger Tiere.

Zur Kenntniss des Ependyms im menschlichen Rückenmark.

Zur Frage von den freien Nervenendigungen in den Spinalganglien. Ueber die Endigungsweise der Nerven an den Haaren des Menschen.

Einige Beiträge zur Kenntniss der intraepithelialen Endigungsweise der Nervenfasern.

Zur Kenntniss der Endigungsweise der Nerven in den Zähnen der Säugetiere.

Die Pacinis'chen Körperchen in Golgi'scher Färbung.

Verzweigte querstreifte Muskelfasern.

RHODE, EMIL. Ganglienzelle, Axencylinder, Punktsubstanz und Neuroglia. *Arch. Mik. Anat.*, XLV, 3, pp. 387-412.

RICHET, CH. Poids du cerveau, du foie et de la rate des mammifères. *Arch. de Physiol.*, 1894, 2, pp. 232-245.

REITZ, EMIL. Beitrag zur Kritik der balkenlosen Gehirne. Inaug.-Diss. 39 pp., 8vo. *Berlin*, 1894.

ROUDNEW, W. Note sur la formation du canal dans le système nerveux central des téléostéens. *Bibliogr. Anatomique*, III, 1, Feb,, 1895.

RUSSELL, J. S. RISIEN. An Experimental Investigation of Eye Movements. *Jour. of Physiol.*, XVII, 1-2, p. 1.

RUSSELL, J. S. RISIEN. The Value of Experimental Evidence in the Diagnosis of Diseases of the Cerebellum. *Brit. Med. Jour.*, 1895, No. 1794.

RUSSELL, J. S. RISIEN. The Influence of the Cerebral Cortex on the Larynx. *Proc. Roy. Soc.*, LVIII, 350, 4 Sept., 1895.

RYDER, JOHN A. An Arrangement of the Retinal Cells of the Eyes of Fishes partially Simulating Compound Eyes. *Proc. Acad. Sci. of Philadelphia*, Pt. 1, 1895.

SALA, L. Sull' origine del nervo acustico. *Arch. per le sc. med.*, *Torino*, XVIII, 1894, pp. 293-330, 2 pl.

SALVI, G. Un nuovo metodo di topografia della scissura di Rolando e della scissura di Silvio. *Pisa, T. Nistri & Co.*, 1895, 25 pp.

SANARELLI, G. I processi riparativi nel cervello e cervelletto. *Atti d. R. Accad. d. Lincei*, Anno 287, S. 4, VII, 1890 (Publ. 1894), 4to., 1 pl.

SANDEMEYER, W. Ueber das Verhalten der Geschmacksknospen nach Durchschneidung des N. Glossopharyngeus. *Arch. Anat. u. Phys.* Phys. Ab., 1895.

SANTESSON, C. G. Einige Bermerkungen über die Ermüdbarkeit der motorischen Nervenendigungen und der Muskelsubstanz. *Skand. Arch. f. Physiol.*, V, p. 394.

SANTINI, and ROCCHI. Le piegature cerebrali e le leggi dell' evoluzione. *Viareggio*, 1894, 23 pp.

SCHAFFER, K. Ueber die zeitliche Reienfolge der secundären Degeneration in den einzelnen Rückenmarkssträngen. *Neurol. Cent.*, XIV, 9, 386, 1895.

SCHIMAMURA, S. Ueber die Blutversorgung der Pons- und Hirnschenkelgegend, insbesondere des Oculomotoriuskernes. *Neurol. Cent.*, XIII, 21, p. 771.

SCHIRMER, O. Untersuchungen zur Physiologie der Pupillenweite. *Arch. f. Ophth.*, XL, 5, p. 8.

SCHMIDT, A. Ein Fall vollständiger isoliater Trigeminuslähmung nebst Bemerkungen über den Verlauf der Geschmacksfasern der Chorda tympani und über trophische Störungen. *Dtsch. Zeits. f. Nervenhk.*, VI, 5-6, 1895.

SCHULTZE, O. Anatomie und Entwickelungsgeschichte des Auges. *Jahresber. über d. Leistung. u. Fortschr. im Geb. d. Ophthalmol.*, Jg. XXIV f. 1893; 1894, pp. 1-21.

SIMON, C. and THIRY, G. Des ganglions de la chaine nerveuse ventrale des hirudinées. *Jour. Anat. et Phys.*, 1895, 3.

SIMON, CH. and THIRY, G. Observations sur la structure de la chaine ganglionnaire ventrale hirundinées. *Bul. Soc. des Sciences de Nancy*, 1895, 1, pp. 1-8.

SMIRNOW, ALEXIS. Ueber die Sensiblen Nervenendigungen im Herzen bei Amphibien und Säugetieren. 7 figs. *Anat. Anz.*, X, 23, 10 July, 1895.

SOUQUES, A. Dégénérescence ascendante du faisceau de Burdach et du faisceau cunéiforme, consecutive à l'atrophie d'une racine cervicale posterieur. *C. R. Soc. de biol.*, 25 May, 1895.

SOUQUES, A. and MARINESCO, G. Dégénération ascendante de la moelle épinière. Destruction par compression lente de la queue de cheval et du cone terminal. *La Presse méd.*, 1895, 2 Mch., pp. 75-78.

SPALITTA, F. Effets de l'extirpation du ganglion de Gasser après l'arrachement du ganglion cervical supérieur. *Arch. ital. de biol.*, XXII, p. lix.

SPALLITO. "Mechanisme de la dilatation pupillaire par excitation des nerfs sensitifs." *Arch. de Farmacologia e Terapeutica*, 1 Mch., 1895.

SPITZKA, E. C. Note on the Localization of Tactile Impressions in the Brain. *The Lancet*, 1895, 3725, pp. 141-143.

SPOURGITIS, J. Sur un rameau musculaire très rare fourni par le nerf cubital. *Bull. Soc. Anat. de Paris*, 1895, 10.

STADERINI, R. Sur un noyau de cellules nerveuses intercalé entre les noyaux d'origine du vague et de l'hypoglossie. *Arch. ital. de biol.*, XXIII, 4, p. 41, 1895.

STADERNI, R. Richerche sperimentali sopra la origine reale del nervo ipoglosso. *Intern. Monats. f. Anat. Physiol.*, XII, 4, p. 220, 1895.

STARLINGER, J. Die Durchschneidung beider Pyramiden beim Hunde. *Neurol. Cent.*, XIV, 9, p. 390, 1895.

STEFANI, M. Del trofismo delle fibre nervose periferiche, stato attual della questione. *Riv. veneta d. sc. med.*, Anno 12, T. XX, Fsc. 6, 1895.

STEINACH, E. and WIENER, H. Motorische Functionen hinterer Spinalnervenwurzeln. *Pflüger's Arch.*, LX, p. 593.

STEINER, J. Ueber die Entwickelung der Sinnessphären, insbesondere der Sehsphäre. *Sitzb. d. k. preuss. Akad. d. Wiss. Berlin, phys.-math. Cl.*, v. 21, March, 1895.

STELLA, H. DE. Contribution à l'étude histologique du système nerveuse chez la grenouille. *Ann. Soc. Méd. de Gand*, 1894, p. 237, 1 pl.

STERN, R. Ueber periodische Schwankungen der Functionen der Grosshirnrinde. *Berliner klin. Woch.*, 3 Dec., 1894. No. 49, p. 1111.

STRONG, OLIVER S. The Cranial Nerves of Amphibia. *Jour. of Morph.*, X, pp. 103-230.

STROUD, B. B. The Mammalian Cerebellum. Part 1. The Development of of the Cerebellum in Man and the Cat. *Jour. Comp. Neurol.*, V, July, 1895.

STUDNICKA, F. K. Zur Anatomie der sog. Paraphyse des Wirbelthiergehirns. *Sitzb. königl. böhm. Gesell. der Wissenschaften*, 1895.

STUDNICKA, F. K. Beiträge zur Anatomie und Entwickelungsgeschichte des Vorderhirns der Craniota. Erste Mitt. *Sitz. k. böhm. Ges. Wiss., Math.-Naturwiss. Classe*, 1895, 42 pp,, 7 pl.

STUELP, O. Zur Lehre von der Lage und der Function der einzeln Zellgruppen des Oculomotriuskernes. *Graefe's Arch. f. Ophthal.*, XLI, 2, 1895.

SZYMONOWICZ, W. Beiträge zur Kenntniss der Nervenendigungen in Hautgebilden. A. Ueber Bau und Entwickelung der Nervenendigungen in der Schnauze des Schweines. B. Die Nervenendigungen in den Tasthaaren (mit schwellkörperhaltigen Haarbälgen). *Arch. Mik. Anat.*, XLV, 4, pp. 624-654.

TAGLIANI, G. Intorno a cosi detti lobi accessorii e alle cellule giganti della midolla spinale di alcune Teleostei. Notizie storiche, anatomische e morfologische preliminairi. *Boll. d. soc. d. natur. in Napoli*, S. 1, IX, 1, 1895.

TIMOFEEW, T. Ueber eine besondere Art von eingekapselten Nervenendigungen in der männlichen Geschlechtsorganen bei Säugetieren. *Anat. Anz.* XI, 2, 22 Aug., 1894.

TIRELLI, VITIGE. Dei processi riparativi nel ganglio intervertebrale. *Annali di Freniatria*, V, 1, May, 1895, pp. 9-26.

TIRELLI, V. Des processus réparateurs dans le ganglion intervertébral. *Arch. ital. de biol.*, XXIII, 3, 1895.

TOTTI, A. Die Functionen des Larynx und ihre centrale Innervation. *Intern. Centralb. f. Laryngol.*, XI, 7, p. 363, 1895.

TRAUTMANN, MAX. Ueber die Nerven der Schilddrüse. Inaug.-Diss. Halle. *Guben*, 8vo., 21 pp., 1895.

TREBAULT, V. Note sur le nerf intestinal des oiseaux. *Bull. muséum d' hist. nat. de Paris*, No. 5, 1895.

TRINCHESE, S. Nervi motori e nervi sensitivi del Phyllobranchus Borgninii Tr. *Rend. Accad. sc. fis. e matem. di Napoli*, Anno 33, (2) VIII, 11-12, 1894, pp. 190-191.

TURNER, WM. A. The Results of Experimental Destruction of the Tubercle of Rolando. *Brain*, LXX-LXXI, Summer and Autumn, 1895.

UEXKUELL, J. v. Zur Methodik der mechanischen Nervenreizung. *Zeits. f. Biol.*, N. F., XIII, 1, p. 148.

VALENTI, G. Sullo sviluppo dell' ipofisi. *Anat. Anz.*, X, 17, 23 April, 1895, pp. 538-540, 1 fig.

VALENTI, G. Sullo sviluppo dell' ipofisi. Nota preventiva. *Monit. zool. ital.*, VI, 1, pp. 13-14.

VALENTI, G. Sullo sviluppo dell' ipofisi. *Atti d. soc. tosc. d. sc. natur.*, IX, pp. 204-206 and 230-231.

VALENZA. Una notevole eterotopia della sostanza grigia dei funicoli gracili e cuneati. *Atti dell' XI. congr. med. internaz. Roma*, 1894, II, Anat., p. 80.

VAS, F. Das Verhältniss des Nervus vagus zum Nervus accessorius Willisii. *Ungar. Arch. f. Med.*, III, 2, p. 129.

VASSALE, G. and DONAGGIO, A. Di alcune particolarità di struttura dei centri nervosi osservate con l'uso dell' aldeide acetica nell' applicazione del metodo Golgi. *Rev. sperim. di freniatr.*, XXI, 1, 1895.

VASSALE, G. and SACCHI, E. Expériences ulterieures sur la glande pituitaire. *Arch. ital. de biol.*, XXII, 3.

VELHAGEN, C. Experimentelle und anatomische Untersuchungen über die Heilungsvorgänge bei der Neurectomia optica des Kaninchens. *Arch. f. Augenhk.*, XXIX, 3-4, p. 345.

VITZOU, A. N. La neóformation des cellules nerveuses dans le cerveau du singe, consécutive à l'ablation complète des lobes occipitaux. *C. R. Acad. Sc.*, CXXI, 12, 1895.

VOGT, ORKAR R. Ueber Fasersysteme in den mittleren und caudalen Balkenabschnitten. *Neurol. Cent.*, XIV, 5-6, 1895.

VOGT. Ueber die Fasersyteme der mittleren und caudalen Balkenabschnitte. *Allg. Z. Psychiat. u. psych.-gerichtl. Med.*, LI, 4, 1894, pp. 812-815.

VOLLMER, E. Nerven- und Nervenendigungen in spitzen Condyomen. *Arch. f. Derm. u. Syphilis*, XXX, 3, p. 363, 1895.

DE VOS, J. Etude de l'innervation de l'ovaire. *Bull. Acad. R. de méd. de Belgique*, S, 4, VIII, pp. 552-558, 2 pl., 1894.

WALDEYER. Ueber einige Gehirne von Ost-Afrikanern. *Correspondenzbl. Ges. Anthrop.*, 1894, 10, pp. 151-154.

WALLER, A. D. Points Relating to the Weber-Fechner Law. Retina; Muscle; Nerve. *Brain*, LXX-LXXI, Summer and Autumn, 1895.

WILDER, BURT G. The Cerebral Fissures of two Philosophers, Chauncey Wright and James Edward Oliver. *Jour. Comp. Neurol.*, V, July, 1895.

WILDER, BURT G. The Cerebral Fissures of two Philosophers, Chauncey Wright and James Edward Oliver. *Jour. Nerv. Ment. Disease*, N. S. XX, II, Nov., 1895.

WINDSCHEID, F. Die Nervenendigungen in den wieblichen Genitalien. Anatomisches und Klinisches. Sammelreferat. *Monats. f. Geburtsh. u. Gynäkol.*, I, 6, 1895.

WINKLER, C. On tropische zenuwen. *Nederl. Weekbl.*, I, 16.

WINKLER, C. Over den involved der uitrolling van twee vagi op den spiernand van het heart. *Psychiat. Bl. Amsterdam*, 1894, XII, p. 145-152.

ZIENHAGEN, PAUL. Beiträge zur Anatomie der Fischaugen. Inaug.-Diss. *Berlin*, 1895, 51 pp., 8vo.

1093